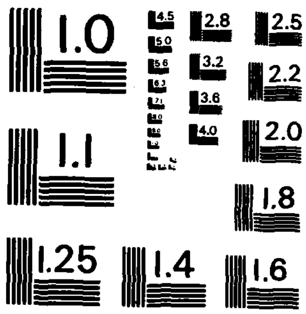
AD A136 694 A STUDY OF THE WEATHER RECORD FROM FANOE (1872 1980) 1/
INCLUDING AN ANALYSIS OF CLIMATE VARIATION(U) RISOE
NATIONAL LAB ROSKILDE (DENMARK) E W PETERSON APR 83

UNCLASSIFIED RISOE R 483 F/G 4/2 NL

END
DATE
FILMED
2 84
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Risø-R-483

RISØ

Risø-R-483

A136694

A Study of the Weather Record from Fanø (1872-1980) including an Analysis of Climate Variation

Ernest W. Peterson

Risø National Laboratory, DK-4000 Roskilde, Denmark

April 1983

RISØ-R-483

A STUDY OF THE WEATHER RECORD FROM FANØ (1872-1980) INCLUDING AN ANALYSIS OF CLIMATE VARIATION

Ernest W. Peterson

Abstract. A study of the weather record from 1872 to 1980 from the island of Fanø, on the west coast of Jutland in Denmark, supports the findings of earlier studies which indicate that the period of the 1930's and 1940's were, climatologically, warmer than the preceeding 50 years and since about 1950. Although the annual precipitation increased up until about 1920 and remains relatively constant since, there was a maximum in shower activity, a minimum in the annual number of cyclone passages, and a maximum in the length of dry episodes in the 1930's and 1940's. There was also a climatological maximum in the severity of the winters during that period.

(continue on next page)

April 1983
Risø National Laboratory, DK 4000 Roskilde, Denmark

The climatological trends are clearly, indicated in the data, when averaged over 30 years or so, and the trends in several different climate variables determined from independent measures of the weather at Fanø are consistent with each other. However, the sizes of the trends in climate are at least an order of magnitude smaller than the standard deviations of the interannual variations in most of the weather measures. Over periods of several generations these small variations in climate cannot have had any effect on human activity when compared with the large effects caused by the interannual variability in the weather.

UDC 551.582 (489.4)

ISBN 87-550-0925-5
ISSN 0106-2840

Risø Repro 1983

TABLE OF CONTENTS

1. INTRODUCTION

Recently long-term, continuous weather records have been transcribed to magnetic tape, which puts them in a form suitable for analysis with the aid of a computer. Before this time the number of data was too large for analysis except in the most superficial of ways. With the aid of a computer one is now able to look at these records in some detail and therefore glean information about interesting past weather events and climatic trends. This report presents the results of a study of the weather record (1872-1980) from the island of Fanø, on the west coast of Jutland, in Denmark. It is the first of several investigations which are planned for the purpose of discovering how the climate in Denmark and the region encompassing northwestern Europe has varied over the past century, since detailed weather records have been kept. A summary of the results is presented in Section 2 and the results of the detailed analyses are found in Section 3.

2. SUMMARY AND CONCLUSIONS

2.1. Evidence of Climate Variation

The year-to-year variation in weather patterns is quite large when compared to the changes in climate which occur over periods of less than a few hundred years. As is discussed in Section 3.1, there has been evidence that a warming trend has taken place in the northern hemisphere, beginning sometime in the 19th century and continuing up until the 1940's. This trend is not at all evident from the record when the year-to-year variation in the weather is retained. Only when the interannual variability is subdued by means of taking long-term averages

does this trend reveal itself. The data from Fanø support the temperature trend seen elsewhere. In addition there is evidence from other measurements taken at Fanø that the climate has indeed varied over the past century.

The 30-year running mean of the pressure record shows a climatological trend towards higher pressure, peaking at about 1930 and decreasing since. The record of cloudiness shows a corresponding trend towards less cloudiness in the 1930's and 1940's than before or since. Since, on the average, higher pressure goes with less cloudiness, the records of the two weather variables are in accord with each other and support the validity of the independent measurements of pressure and cloud cover. The temperature record is also supported by the pressure and cloudiness record in that higher pressure and fewer clouds mean more sunshine, therefore more heating by solar radiation and thus higher temperatures.

The precipitation record is more difficult to interpret. The evidence from Fanø is that the precipitation has increased through at least the first third of the 20th century, and, as can be seen in Section 3.3, this trend is observed at other stations in northwestern Europe. This increased precipitation in the face of higher pressure and fewer clouds is apparently contradictory. However, in these latitudes, precipitation is limited by temperature: the moisture content of the air greatly increases with a small increase in temperature when the supply of water vapor is unlimited, as it is in a marine environment. Thus it is physically realistic to have increased precipitation along with less storminess and less average cloudiness if the temperature has increased. As can be seen in the Section 3.3, climatologically there has been an increase in the number of days of shower activity and a decrease in the number of cyclone passages at Fanø during the period in which the temperature, pressure, precipitation, and cloudlessness were increasing.

From the literature, see e.g. Lamb (1969 and 1972), one finds that apparently the climatological position of the storm track over northern Europe was farther south during the 1930's and

1940's than before or since. This is in accord with the climatological trends found from the Fanø record.

Figure 2.1 shows a graph of the 30-year running means of the pressure, temperature, precipitation, and cloudlessness records, normalized by their respective means and standard deviations. Note the obviously good correlation between these independent records from the 19th century up through the 1940's. The record since then is too short to make any firm conclusion about the present trend, but it appears to be changing towards a return to the climate found in the early part of the 20th century.

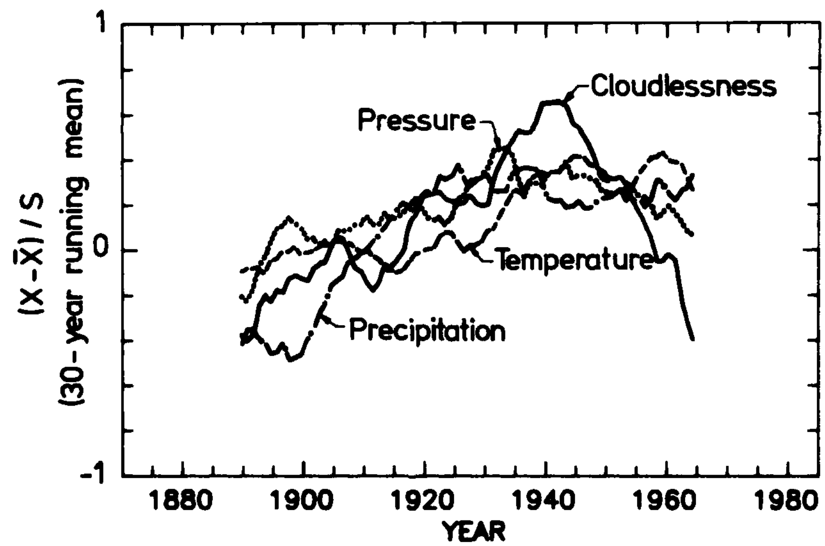


Fig. 2.1. Normalized 30-year running means of pressure, temperature, precipitation, and cloudlessness from Fanø. Each variable was normalized with its respective mean and standard deviation.

2.2. Conclusions

When one examines the details of the weather record at Fanø, even the 30-year means do not give an unambiguous picture of the trends in the climate, though one can begin to see connections between the trends in various measures of the climate.

The temperature record indicates that, climatologically, summer temperatures were higher in the 1930's and 1940's than before or since, while trends in the winter temperatures are less apparent. There were longer periods of low temperatures in this period than before or since and there is some evidence of shorter episodes of warm weather during the period. The number of frost days was higher in the 1930's and 1940's than before or since, while there has been a downward trend in the number of degree days since the beginning of the record.

Precipitation increased up to about 1920 and has been relatively constant since. There is some indication that the length of periods of dry weather had a maximum during the 1930's and 1940's. The increase in precipitation seems to be due primarily to an increase in shower activity, since the frequency of cyclones had a minimum during this period. Along with a maximum in the 30-year running mean pressure there was a corresponding minimum in the cloud cover.

No definite conclusions can be drawn from the wind record. The wind speed information is not very useful since it resulted from an attempt to make precise the subjective interpretations of the various observers, each of whom had their own personal method for categorizing the winds. The official scale for categorizing the winds also changed over the century and a one-to-one correspondence between one scale and another was not found. The prevalence of the westerlies appears to have decreased somewhat over the century but it is necessary to investigate other wind records from the region before any conclusions can be made of the reality of this phenomenon.

The record from Fanø supports other evidence indicating a warmer, drier (except that there was more precipitation due to increased shower activity) climate duing the 1930,s and 1940's than before or since. The record contains more detail than has heretofore been presented, in that it was possible to analyze the pressure and cloud cover record for the past century as well as the usual temperature and precipitation information that has been studied for other places by earlier investigators.

The short record since the 1940's suggests that the climate in northwestern Europe is beginning to cool again. The interannual variability of the weather is very large when compared to the variability in climate. There is no way in which a human observer could be aware of the climate changes over his lifetime, and any suggestion that the observed weather is to any signifiacant extent different than it was a generation ago is apocryphal. The effect of year-to-year variations in weather on human activity is great; the effect of variations in climate over the past century is nil.

3. ANALYSIS OF WEATHER DATA

The data used for this study was supplied originally by the Danish Meteorological Institute. The data were scanned for errors and missing information by N. Brown (see Brown et al., 1983), and the faulty material corrected. The magnetic tape containing the corrected data was supplied to Risø by Brown. For details about these corrected data and the observations from which they resulted, one is referred to Brown et al. (1983).

The corrected data contain information concerning the weather at Fanø from November 1872 through December 1980. For most of this study only that data from October 1874 through September 1980 were used. The record contains the following information, from observations made three times a day, at 0800, 1400, and 2100 hours: pressure, temperature, relative humidity, wind speed and direction, visibility, precipitation, maximum and minimum temperatures, snowcover, snowdepth, past weather, present weather, and cloud cover.

3.1. Temperature

Temperatures at Fanø were measured by two independent instruments: a maximum-minimum thermometer, and an ordinary thermometer at 0800, 1400, and 2100 hours. The two temperature records were compared and, on the average (i.e. at least for annual and seasonal means), found to agree with each other. As the maximum-minimum thermometer measures the temperatures of most use for climatological purposes, most of the discussion in this section is based on temperatures measured by this instrument.

Since the purpose of this study was to determine which, if any, features of the climate at Fanø have varied over the past century, it was necessary to choose some way of reducing the weather for a particular year to some small set of numbers. In this section, which is concerned only with temperature measurements, many graphs are presented of quantities deduced from the temperature record, plotted as functions of year. By examining each graph, one can pick out unique features such as, the year with the coldest or warmest month of the century, the year of the peak in the 30-year running mean of the temperature of the coldest month, the year with the longest period in which the temperature did not rise above 0C, and so on, ad infinitum. One quickly comes to the realization that each year is unique, each has features peculiar to that particular year, and that it is not really possible to grasp the long-term trends in whatever features that are of interest by compiling lists of the peculiarities of individual years. In fact, even in making long-term averages of various quantities and looking for trends in the averages, one is faced with difficult decisions as to which quantities and in which manner they should be dealt with. There are innumerable ways to look at the temperature record and the graphs displayed here are by no mean necessarily the best selection one can make, but by studying them one can get some idea of the way the weather varies year by year and how the climate varies at a coastal station n northern Europe.

3.1.1. Monthly mean Temperature

Figure 3.1.1a is a plot of the mean temperature for each month as a function of year. (The mean temperature is defined as the average of the maximum and minimum temperatures). There are 12 curves, one for each month, and as one can see, there is a lot of variation from month to month and year to year. One can pick out certain features that may be of interest, e.g. the coldest month in the record occurred in 1929, and the warmest month occurred in 1947. Any climatological trends, however, are obscured by the large interannual variation in each monthly temperature.

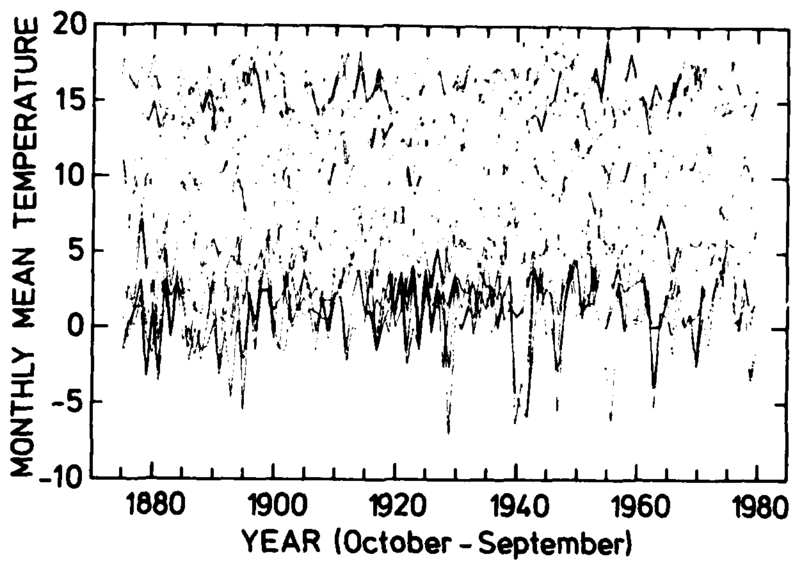


Fig. 3.1.1a. Mean monthly temperatures at Fanø as functions of year.

Figure 3.1.1b displays the 30-year running means of the monthly mean temperatures shown in Fig. 3.1.1a. (Since it is customary to use 30-year means in discussing climatic features, they are used throughout this study). One can see trends in the 30-year mean monthly temperatures. The 30-year mean summer temperatures were lower in the early part of the 1900's than they were in the period centered around the 1940's. They seem to be declining now. Some of the transitional months show an increase in the

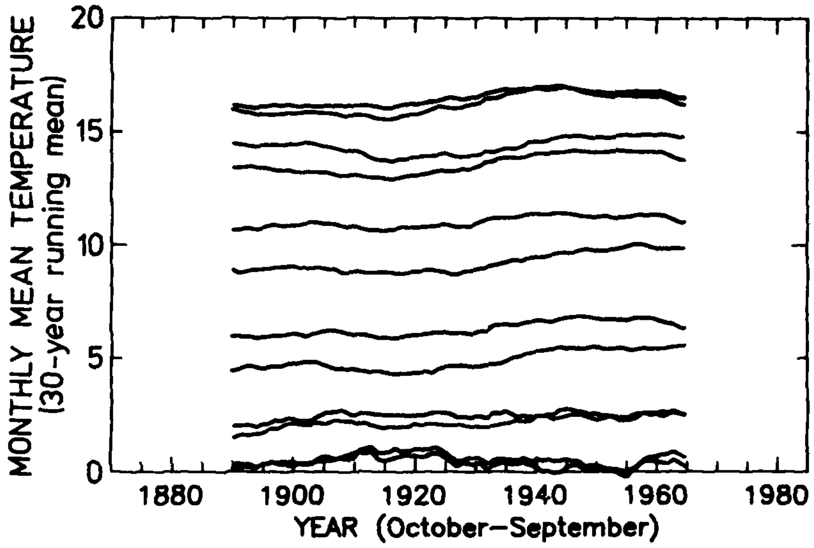


Fig. 3.1.1b. Mean summer and mean winter temperatures at Fanø as functions of year.

30-year mean temperature, continuing to the present day. The 30-year average of the temperatures during the coldest winter months show maxima in the 1910's and 1920's, minima in the 1940's and 1950's and have then increased again. However, the trends in the temperatures for the winter months are smaller than those for the summer and transitional months.

3.1.2. Seasonal Mean Temperatures

For the purpose of viewing summer and winter seasons separately, the year was counted as beginning in October of the preceeding calendar year, so as not to divide the winter between two years. Most of the graphs in this report, and all of those dealing with the seasons, use the "seasonal year", i.e., that beginning in October. The winter season is counted as November through March, and the summer season is defined as May through September, except as noted. October and April are considered as transitional months, not properly fitting into either the summer or winter seasons. Figure 3.1.2a shows the interannual variations of the winter and summer mean temperatures. Even though the curves are

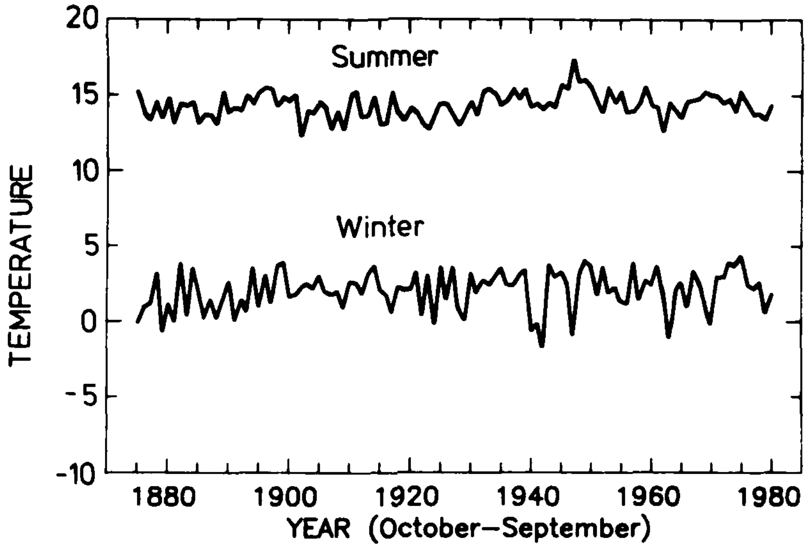


Fig. 3.1.2a. Mean summer and mean winter temperatures at Fanø as functions of year.

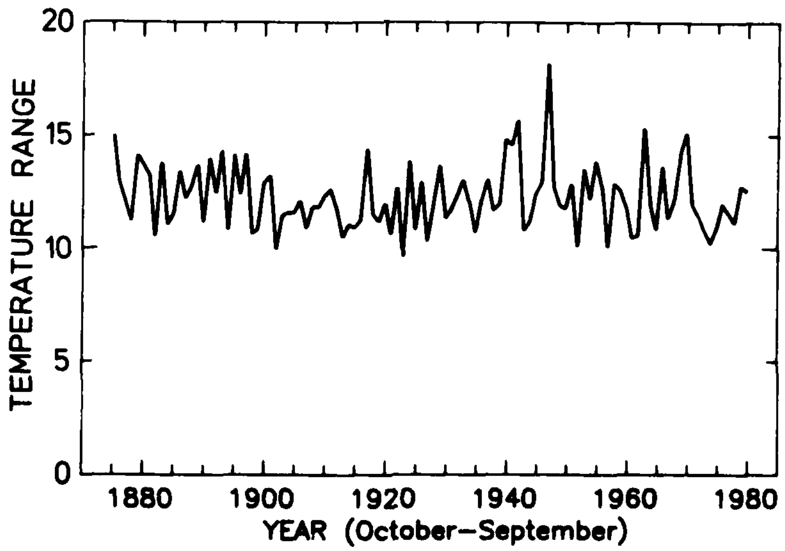


Fig. 3.1.2b. Mean temperature difference between summer and the preceeding winter at Fanø, as a function of year.

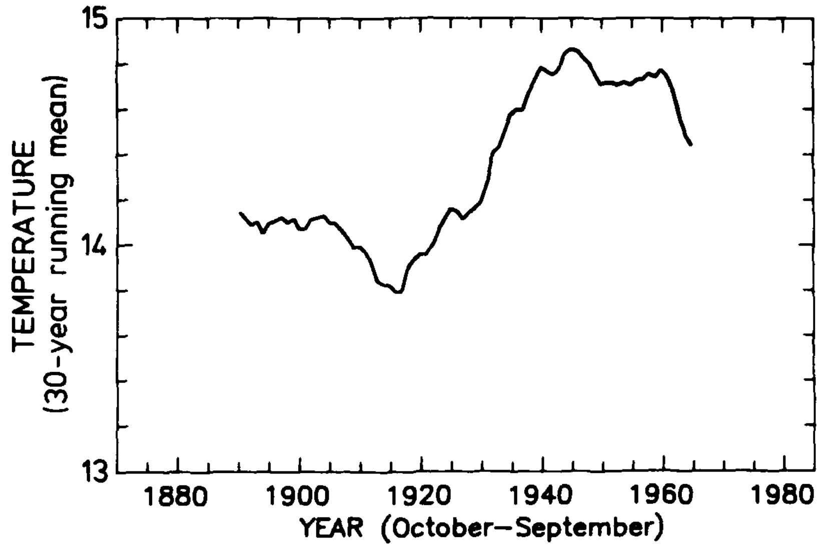


Fig. 3.1.2c. 30-year running mean of the summer temperature at Fanø.

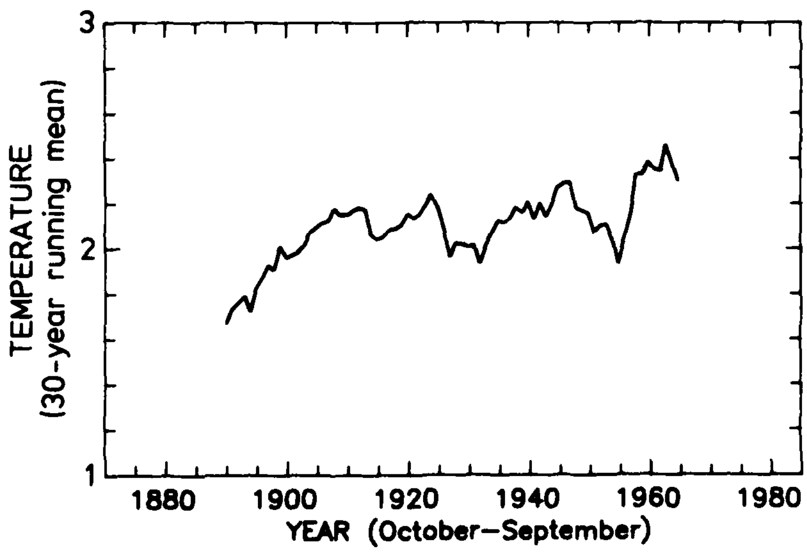


Fig. 3.1.2d. 30-year running mean of the winter temperature at Fanø.

much smoother than the curves for the individual months shown in Fig. 3.1.1a, there is still much interannual variation and no trends are discernible. Note the three consecutive cold winters of 1940, 41, and 42, and the extremely warm summer of 1947. Figure 3.1.2b shows the temperature difference between the summer mean and the mean temperature of the preceeding winter. Note the unusually large difference between the summer and winter temperatures of 1947, which had a quite cold winter followed by the warmest summer of the record. Figure 3.1.2c displays the yearly variation of the 30-year mean summer temperature. Note the minimum in 1916 and the maximum in 1945. Figure 3.1.2d shows the yearly variation of the 30-year mean winter temperature. There is a lot of variation, even when the winter temperature is averaged over such a long time, however, there appears a slight trend to warmer winter (30-year mean) temperatures since the latter part of the 19th century.

3.1.3. Annual Mean Temperatures

The trend in the 30-year mean temperature is displayed in Fig. 3.1.3a showing a definite increase in the 30-year mean temperature since the early part of the 20th century. Figure 3.1.3b shows the trends in the 30-year means of the daily maximum, minimum, and mean temperatures, and the difference between the maximum and minimum temperatures. There is a much more pronounced trend in the maximum temperature, toward increasing temperatures up until at least 1945, then in the mean temperature. The 30-year mean minimum temperature shows no particular trend at all. This is further illustrated by the distinct trend, toward increased difference between the maximum and minimum temperatures, in the 30-year mean temperature range. Figure 3.1.3c shows the annual variation of the yearly averages of the temperatures observed at 0800, 1400, and 2100 hours. The 30-year means of these quantities are displayed in Fig. 3.1.3d, along with the mean temperature as measured with the maximum-minimum thermometer. This shows the general agreement between the two, independent measures. Note particularly the agreement between the 30-year mean temperature trend and that of the 30-year mean of the temperature measured at 1400. This illustrate that a

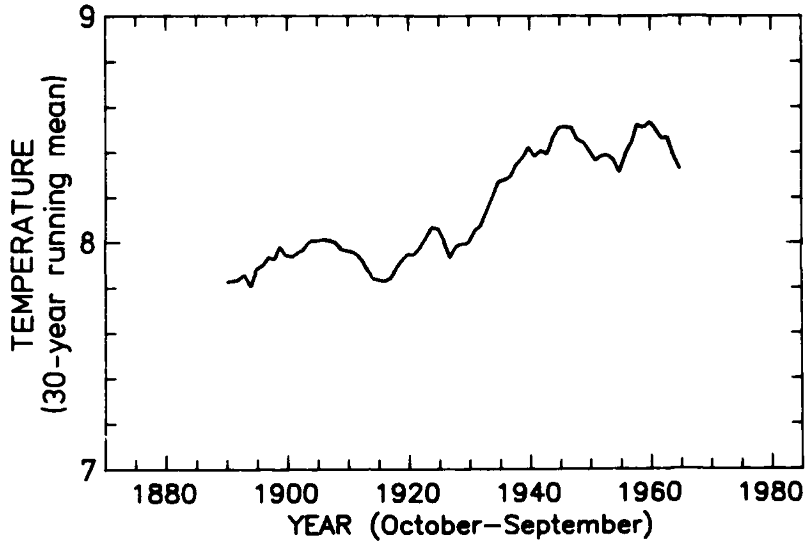


Fig. 3.1.3a. 30-year running mean of the mean annual temperature at Fanø.

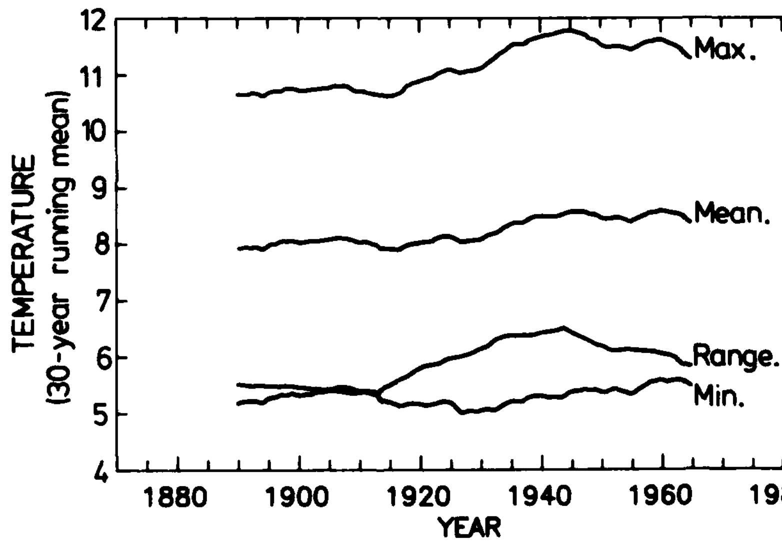


Fig. 3.1.3b. 30-year running means of the yearly average of the daily maximum, minimum, and mean temperatures, and the daily temperature range at Fanø.

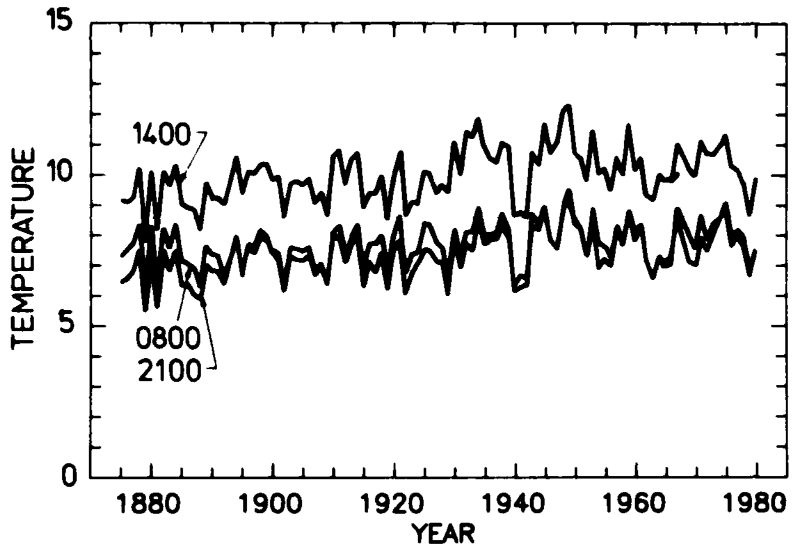


Fig. 3.1.3c. Annual means of the temperatures observed at 0800, 1400, and 2100 at Fanø, as functions of year.

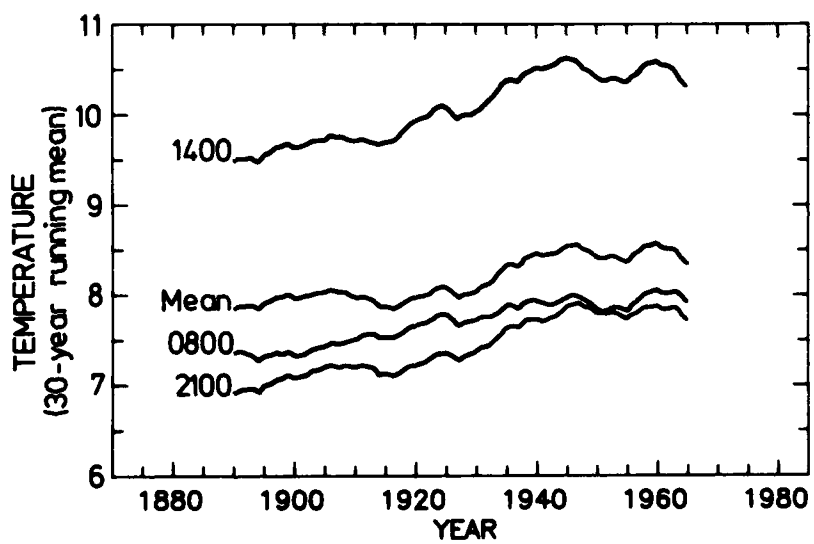


Fig. 3.1.3d. 30-year running means of the temperatures observed at 0800, 1400, and 2100, and of the mean temperature at Fanø.

large part of the trend in the annual mean temperature is due to the daytime rather than the early morning temperature, although one should note the definite increasing trend in the 30-year average of the 2100 hour temperature.

3.1.4. Severe Winters

One measure of the severity of the winter can be the length of the longest period in which the temperature was below a certain value. In this study, three measures of winter severity were computed; the lengths of the longest period in which the minimum, the mean, or the maximum temperature were below 0°C. Figure 3.1.4a show the interannual variation of these quantities. Note that severe winters are somewhat intermittant, and thus one

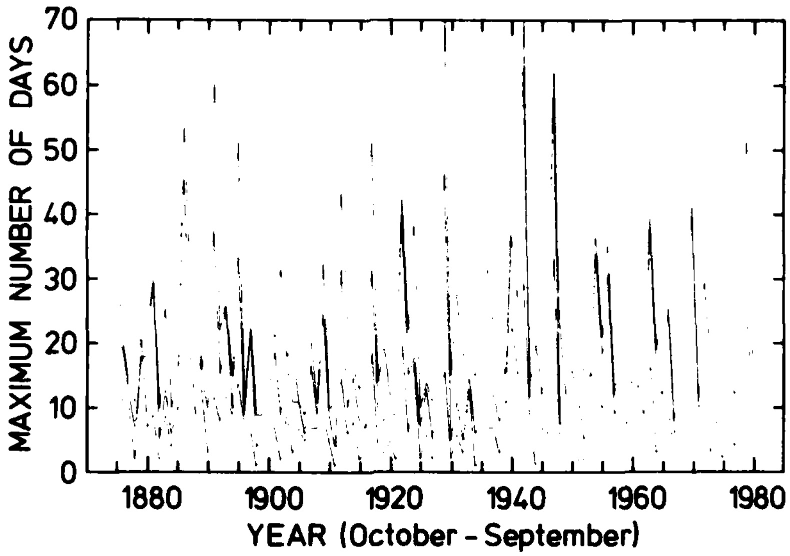


Fig. 3.1.4a. Lengths of the longest periods each year in which the daily minimum, daily mean, and daily maximum temperatures, respectively, do not rise above 0°C at Fanø.

would expect that even 30-year averages should display considerable variation. The winter of 1942 not only had about the longest period, ca. 70 days, in which the minimum temperature

was below 0°C, but even the mean temperature was below 0°C for more than two months. The expected rather large interannual variation in the 30-year means of the severe winter measures is apparent in Fig. 3.1.4b. All three measures fairly closely follow the same pattern, showing minima in the early part of the 20th century, around 1912, and maxima in the 1930's, with definite declines from 1955 onward.

The intermittency of severe winters can also be noted in Fig. 3.1.1a, where the descending spikes every decade or so since about 1930 represent unusually cold winter months. The period from about 1895 to about 1930 was relatively free of extremely cold winter months. These infrequent but relatively quite cold periods are associated with the freezing of the waters surrounding the Danish islands. With these waters frozen the winter becomes more continental because of the loss of the modifying effect on the weather due to the great heat capacity of the sea (see also, Lamb (1972), pp 388-390).

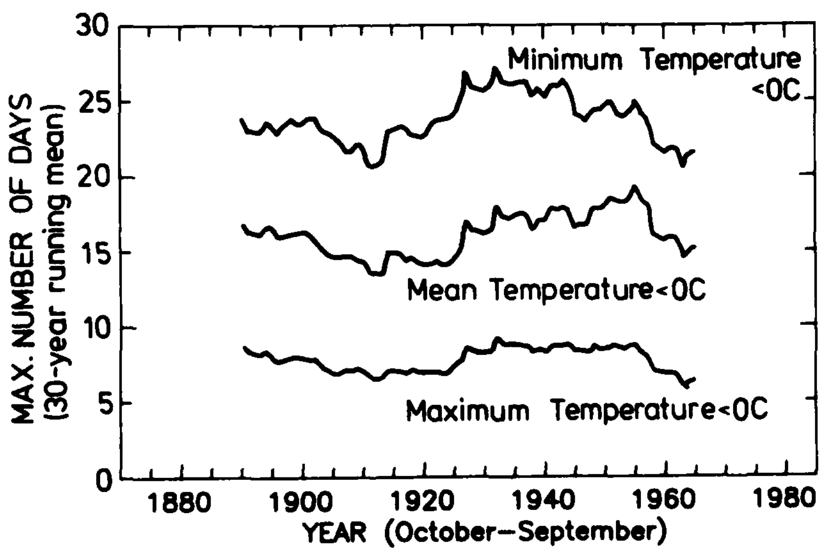


Fig. 3.1.4b. 30-year running means of the lengths of the longest periods in which respectively, the daily minimum, daily maximum, and daily minimum temperatures do not rise above 0°C at Fanø.

3.1.5. Warm Summers

A measure of the warmness of the summer season, or the length of the growing season, is the length of the longest period in which the minimum temperature is above a certain level. Here, two levels were chosen: 0°C and 10°C. Figure 3.1.5a shows the interannual variation of the lengths of the longest periods in which the minimum temperature was above 0°C and 10°C. Again, there is much interannual variation and no discernible trends. Figure 3.1.5b shows the 30-year running mean of the longest period each year when the minimum temperature exceeded 0°C. Note that by this measure summer temperatures were warmer in the 1900's and the 1950's than in the late 1920's or in the 1930's and 40's. Figure 3.1.5c shows the 30-year running mean of the length of the longest period each year when the minimum temperature exceeded 10 degrees. Again, there are peaks around 1910 and in the 1940's and a distinct minimum in 1921. A definite declining trend extends from the 1940's onward.

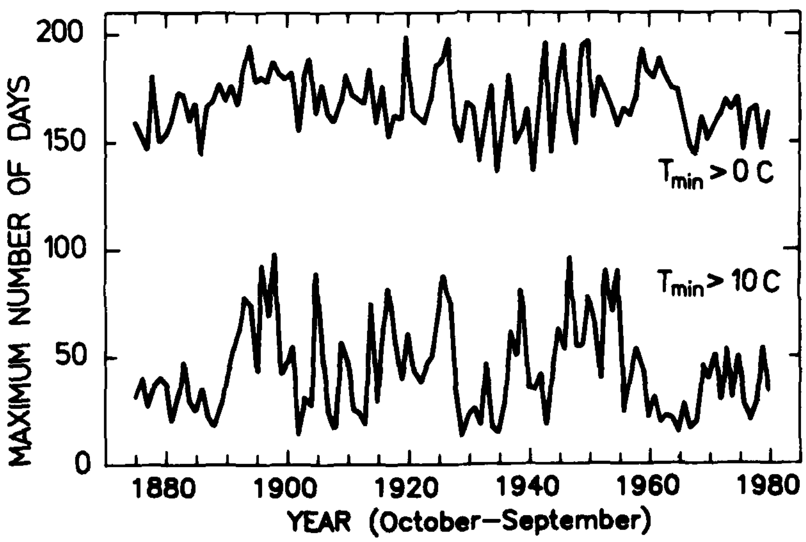


Fig. 3.1.5a. Maximum lengths of periods in which the daily minimum temperatures exceeded 0°C, and exceeded 10°C, at Fanø, as functions of year.

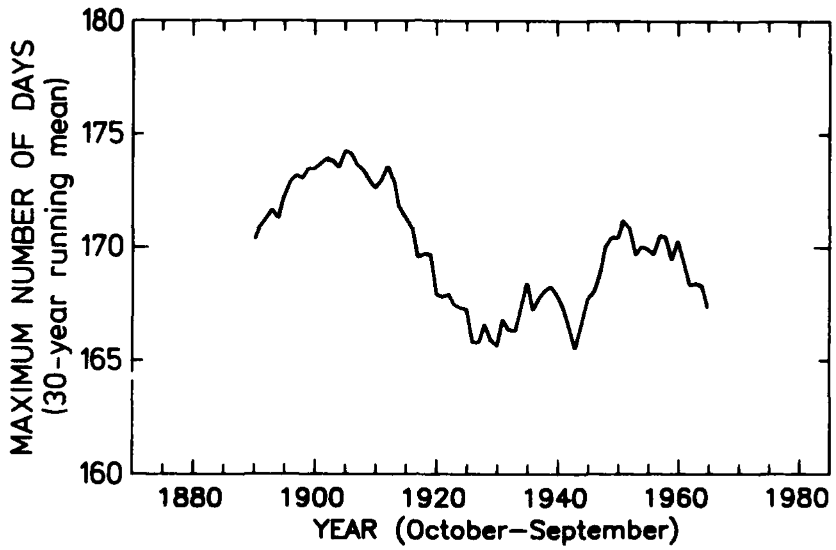


Fig. 3.1.5b. 30-year running mean of the length of the longest period each year in which the daily minimum temperature exceeded 0°C at Fanø.

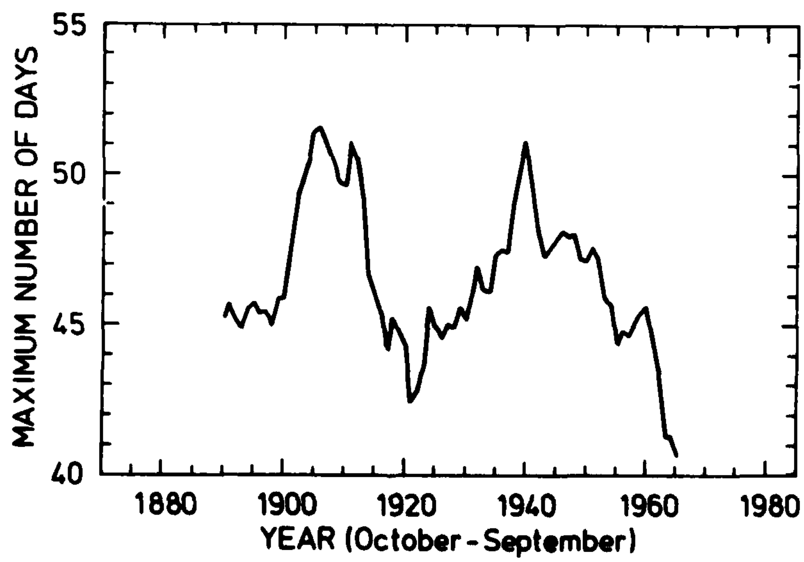


Fig. 3.1.5c. 30-year running mean of the longest period each year in which the minimum temperature exceeded 10°C at Fanø.

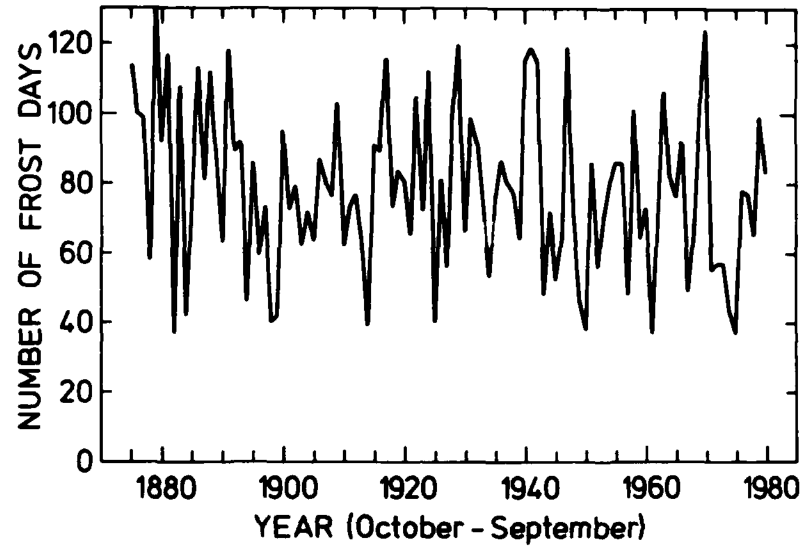


Fig. 3.1.6a. Yearly number of frost days (minimum temperature less than 0°C) at Fanø, as function of year.

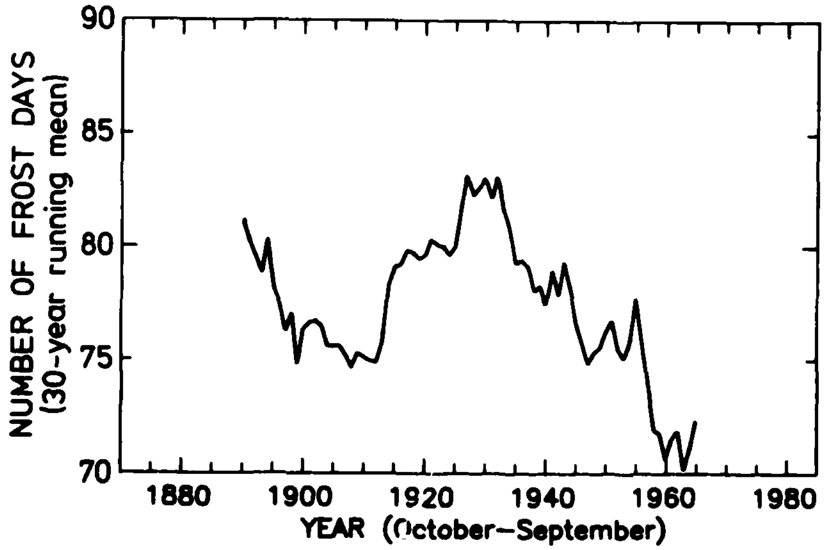


Fig. 3.1.6b. 30-year running mean of the yearly number of frost days at Fanø.

3.1.6. Frost Days

Figures 3.1.6a and 3.1.6b show respectively the interannual variation in the number of days each year in which the minimum temperature fell below 0°C and the 30-year running mean of this quantity. The interannual variation is huge, extending from a maximum of 130 days of frost in 1879 to a minimum of less than 40 days in 1960. The 30-year running mean number of frost days, Fig. 3.1.6b, shows a relatively mild period in the first decade of the 1900's when compared to the period centered around 1930. Since about 1935 there has been a rather steady decline in the the 30-year average number of frost days to the present time.

3.1.7. Degree Days

The total numbers of degree days for the calendar year and for the heating season (October through April) were computed. (The number of degree days each day is defined as the number of degrees the temperature is below 17°C and is zero otherwise). Figure 3.1.7a shows the interannual variation of the total num-

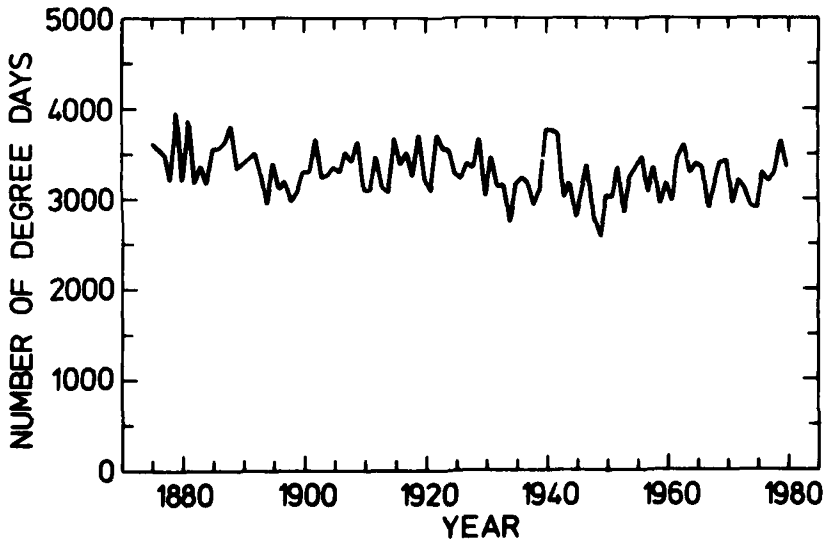


Fig. 3.1.7a. Annual number of degree days at Pane, as a function of year.

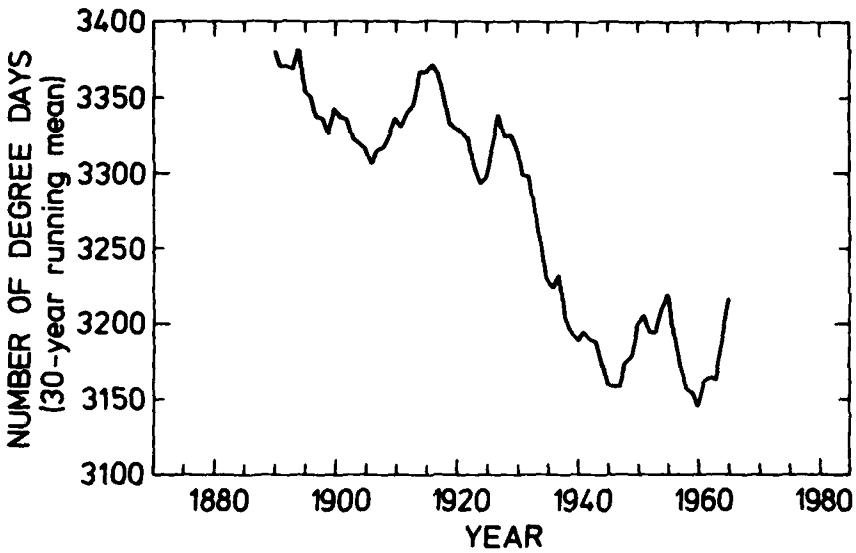


Fig. 3.1.7b. 30-year running mean of the annual number of degree days at Fanø, as a function of year.

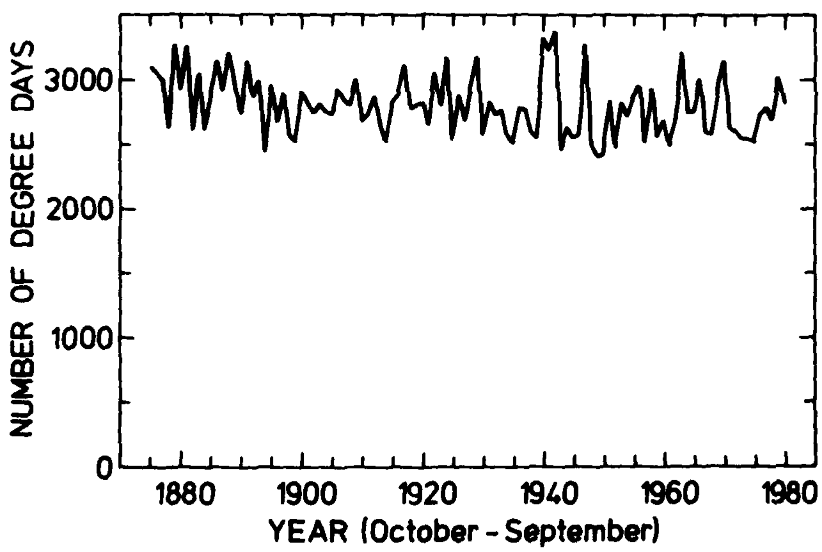


Fig. 3.1.7c. Annual number of degree days during heating season (October-April) at Fanø, as a function of year.

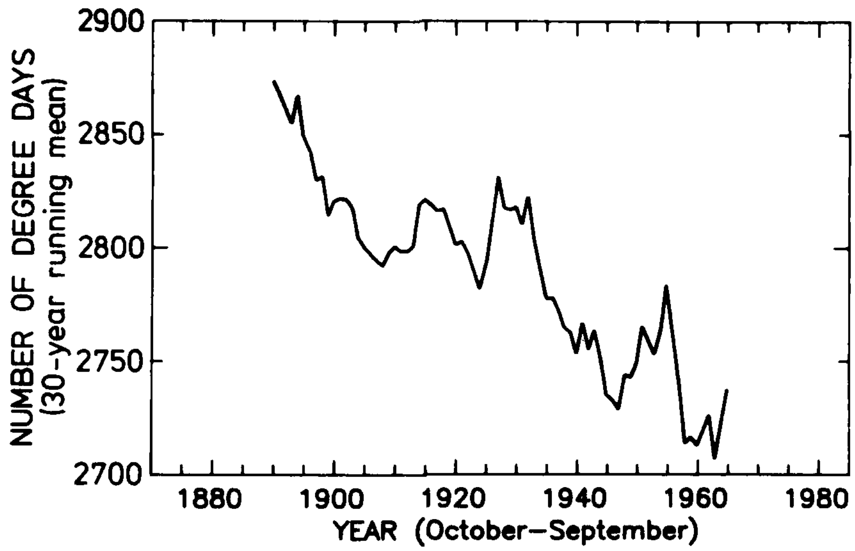


Fig. 3.1.7d. 30-year running mean of the annual number of degree days during the heating season at Fanø.

ber of degree days each year. The quantity varies between about 3000 and 4000 and shows no discernible trend. However, when the 30-year mean of this quantity is plotted, Fig. 3.1.7b, a strong downward trend appears of more than 5% over the century, although there are many intervening maxima and minima. Figure 3.1.7c shows the interannual variation of the number of degree days each year for the heating season and Fig. 3.17.d shows the 30-year running mean of this quantity. The same downward trend in the 30-year mean number of degree days during the heating season each year is exhibited in Fig. 3.1.7d as in the 30-year running mean of the yearly total degree days as shown in Fig. 3.1.7b.

3.1.8. Mean Seasonal Temperatures

Figure 3.1.8 exhibits the averages and standard deviations over over the whole record of the monthly mean and summer and winter temperatures at Fanø. The standard deviations of the monthly, seasonal, and annual mean temperatures are large when compared

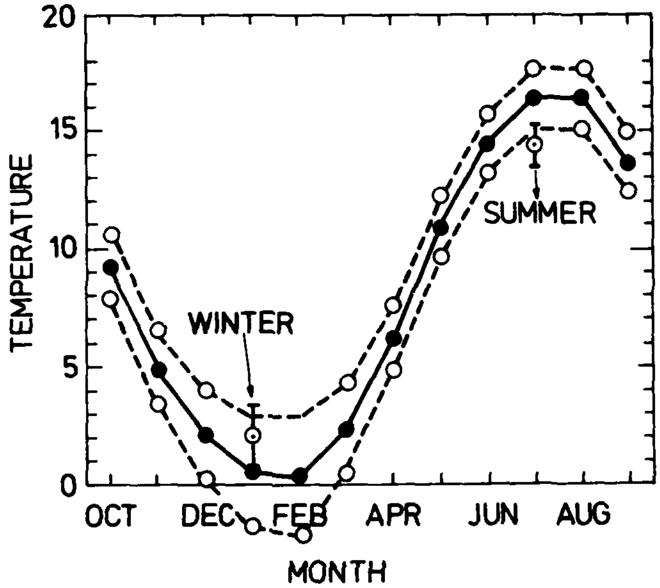


Fig. 3.1.8. Mean (1875-1980) monthly temperatures and standard deviations of the annual variation of monthly temperatures at Fanø.

to the size of the trends discussed in the preceeding portions of this section, further illustrating why the long-term trends in climate are almost completely obscured by the interannual variations in weather.

3.1.9. Conclusions

The general trend in the 30-year mean temperature suggesting a warmer period centered in the 1940's when compared to the early decades of the 20th century and the period since the 1940's is supported by evidence from other studies. Lamb (1969, p. 176) cites several reports supporting an increase in temperature in the northern hemisphere during the first half of 1900's. However, he attributes it mainly to increases in winter temperature. One the other hand, the Fanø record suggests that, at least in northwest Europe, the summer temperature is the more important contributor. The trend in the summer temperature at

Fanø is almost identical to the trend in the summer temperature at Thorshavn in the Faroe Islands (Woetmann, 1978).

In conclusion, there appears to be a definite climatological warming trend at Fanø during the first half of the 20th century. This is expressed primarily by increasing summer temperatures although winter temperatures have also increased, but to a lesser extent and with a much less definite trend. The climatological trend in daily maximum temperature shows a definite increase but there is no discernible trend in the climatological daily minimum temperature. There is a slight indication of a maximum in the climatological occurrence of severe winters during the middle portion of the 20th century when compared to the early part or to the present day. There appears to be a minimum in the climatological length of the growing season during the 1930's and 1940's and the number of days with frost shows a maximum during the same period. The number of degree days, on the average, has decreased by about 5% over the century

Thus the temperature record indicates a somewhat confusing picture as to the climatological trends since the latter part of the 19th century. While there is a definite indication of a relatively warm period in the middle part of the 20th century, this warm period was paradoxically also associated with relatively shorter growing seasons, longer periods of cold weather, and more days of frost than in the early years of the 1900's and the period since the 1940's.

3.2. Humidity

The humidity was measured at Fanø with the use of a wet-bulb thermometer. The measurement was then converted and reported as relative humidity. In this study the relative humidity has been used along with the temperature record to compute the dew point. There appears to be serious problems with the humidity record during the period of the early 1940's, during World War II.

3.2.1. Dew Point

Figure 3.2.1a shows the mean annual dew point for the three observations times, 0800, 1400, and 2100, plotted as a function of year. The record appears reasonable except for the period around about 1943, when there was an apparently unreasonable sharp jump in the mean annual dew point, particularly for that computed for observations made at 1400 hours. The 30-year run-

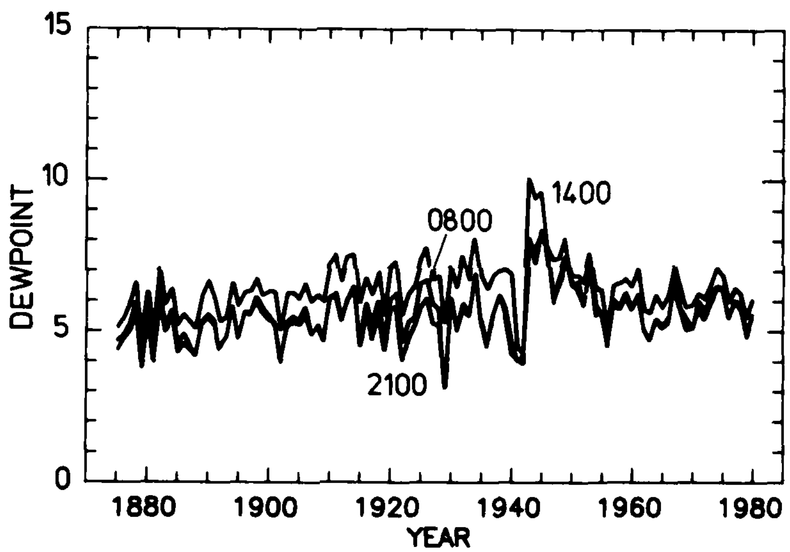


Fig. 3.2.1a. Mean annual dewpoint, at Fanø for the three observation times, 0800, 1400, and 2100, as functions of year.

ning mean dew point temperature is shown in Fig. 3.2.1b and indicates a general climatological trend toward increasing dew point from the late 19th century up until about the 1940's, followed by a decline particularly in the record for the daytime (1400) observation. This trend is consistent with the temperature trend discussed in Section 3.1, though interpretation is hampered by the contamination of the record by the seemingly erroneous data from the early 1940's.

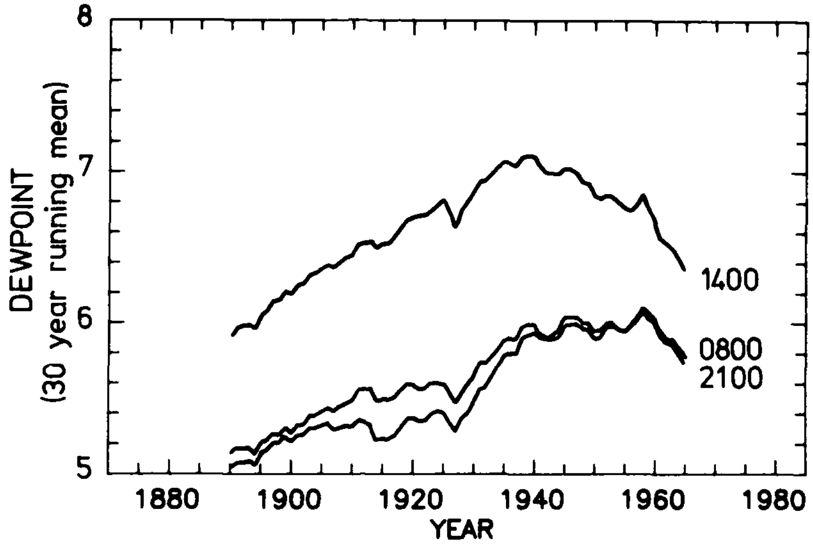


Fig. 3.2.1b. 30-year running mean of the mean annual dewpoints at Fanø for the three observation periods.

3.3. Precipitation

The record from Fanø contains information about the daily precipitation, snowfall, and snow cover. In this study, analysis was confined only to the record of daily total precipitation. Precipitation amounts can vary greatly over only small distances, and the amount collected by a particular rain gauge is much influenced by the local surroundings, which, if they change, such as by the growth of vegetation around the gauge, can effect the amount of precipitation measured. These factors need to be considered when analyzing the record both for totals and trends in precipitation amounts.

3.3.1. Total Precipitation

Figure 3.3.1a shows the annual variation of precipitation at Fanø. The yearly precipitation varies by nearly a factor of three from year to year; 1950 had more than 1050 mm, while 1947 had less than 450 mm. Figure 3.3.1b shows the 30-year running mean of the annual precipitation. There is a rather striking

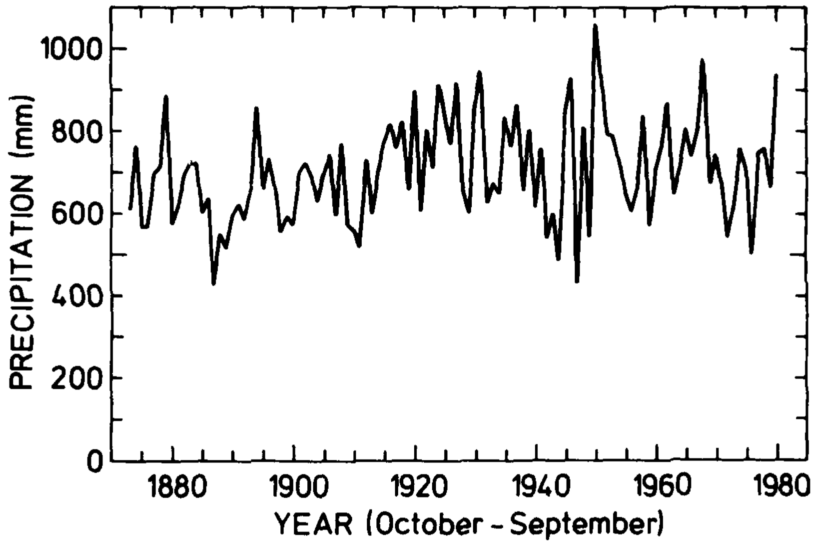


Fig. 3.3.1a. Annual precipitation at Fanø as a function of year.

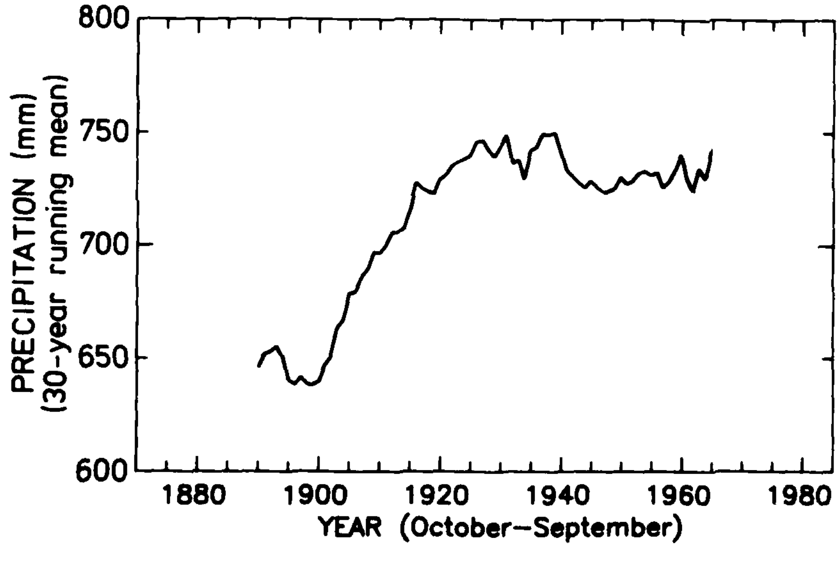


Fig. 3.3.1b. 30-year running mean of the annual precipitation at Fanø.

trend toward increased precipitation up until about 1930 and then remains relatively constant. This could be the result of local factors, as mentioned above, but records from other places in the northeast Atlantic region also show increased precipitation (Lamb, 1969, p. 197) during this period. Figure 3.3.1c shows the winter (October-March) and summer (April-September)

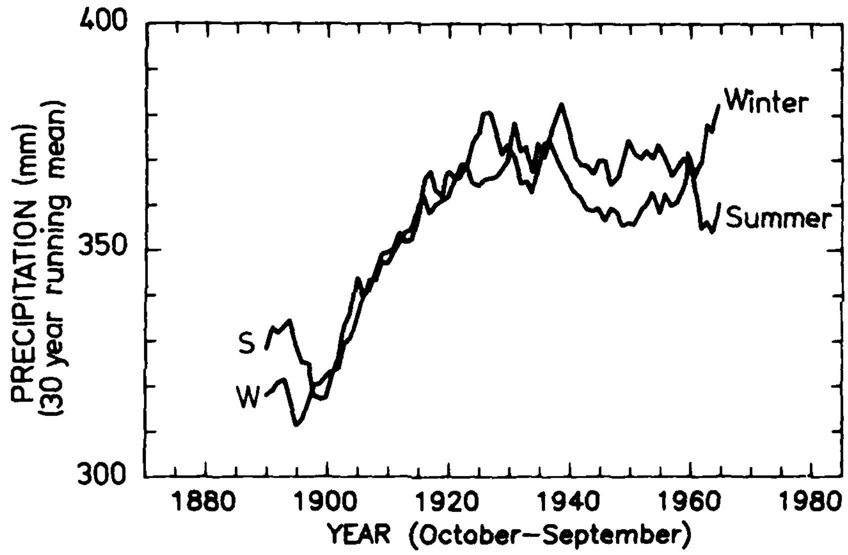


Fig. 3.3.1c. 30-year running means of the summer and winter precipitation at Fanø.

contributions to the 30-year running mean of yearly precipitation. The amounts of precipitation for summer and winter are almost the same and follow the same trend as shown in Figure 3.3.1b. One can conclude based on the Fanø record, and others reported by Lamb, that there has been a climatological trend towards increased raininess in northwest Europe through at least the first third of the 20th century.

3.3.2. Dry Periods

The length of the longest dry period each year (daily precipitation < 0.1 mm) was determined and plotted as a function of

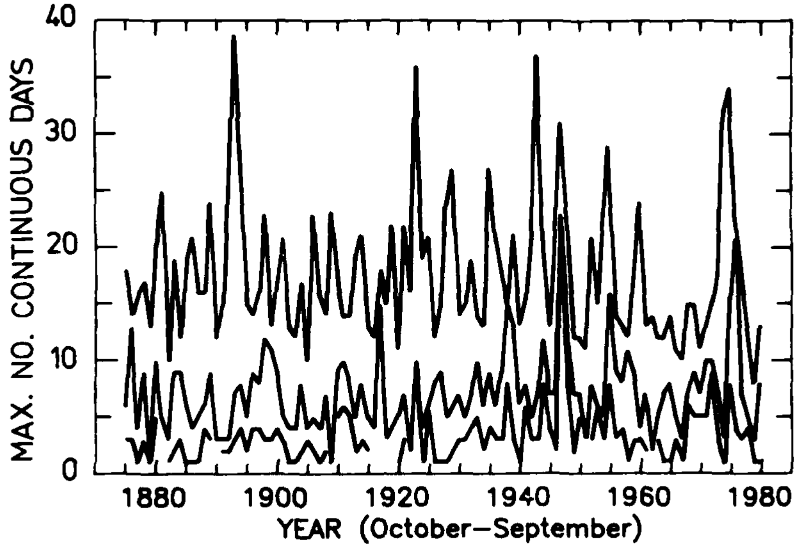


Fig. 3.3.2a. Yearly maximum number of days at Fanø when the amount of precipitation was less than 0.1 mm, and when the precipitation was less than 0.1 mm the maximum temperature exceeded 20°C, and 25°C.

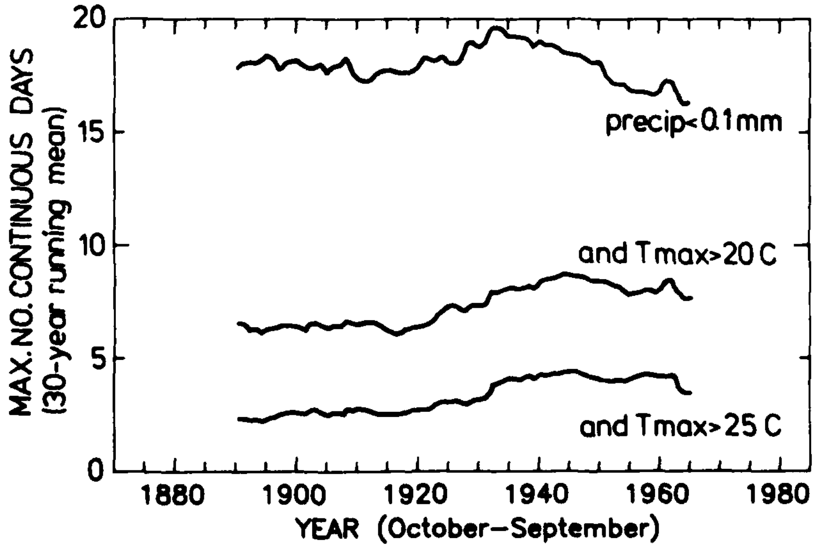


Fig. 3.3.2b. 30-year running means of the yearly maximum number of days at Fanø when the total precipitation was less than 0.1 mm, and when the precipitation was less than 0.1 mm the maximum temperature exceeded 20°C, and 25°C.

year in Fig. 3.3.2a. Warm (maximum temperature > 25°C) dry periods were also determined, and their maximum lengths each year are also plotted in Fig. 3.3.2a. The 30-year running means of these quantities are shown in Fig. 3.3.2b. The climatologically driest period is centered at about 1933, while the warm and hot dry periods lengths appear to have increased up until about 1945. Thus it appears that although there was climatological trend toward increasing precipitation during much of the 20th century, there was also a small increase in the lengths of the dry periods. This suggests a decline in the frequency of steady rain, which was more than made up for by an increase in shower activity.

3.3.3. Showers

The occurrence of shower activity was estimated by searching for those days when the daily precipitation exceeded 20 mm. Figure 3.3.3a shows the number of such occurrences each year plotted as a function of year. They range from zero to eight per year.

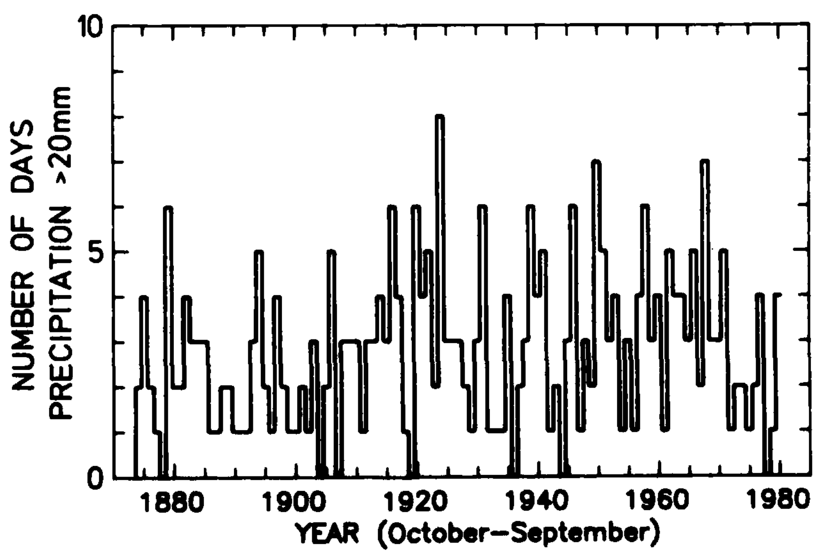


Fig. 3.3.3a. Number of days each year at Fanø when the precipitation exceeded 20 mm.

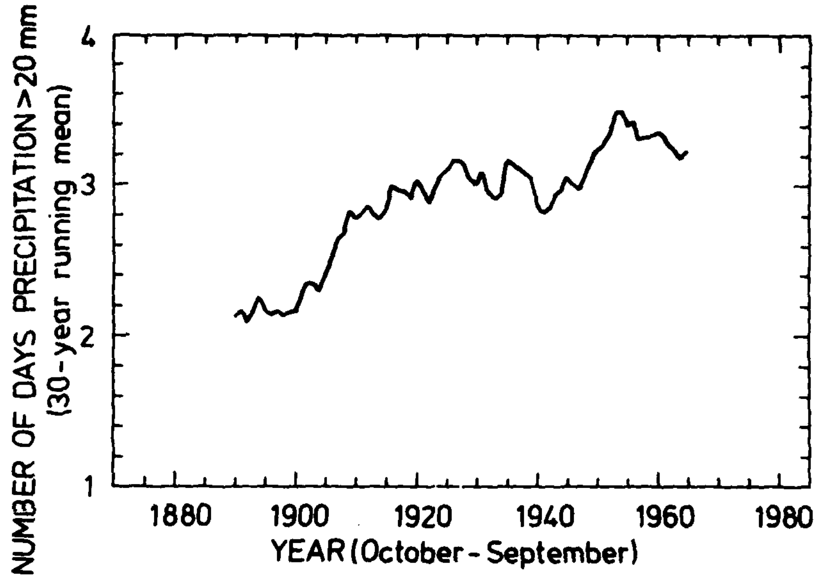


Fig. 3.3.3b. 30-year running mean of the number of days each year, at Fanø, when the precipitation exceeded 20 mm.

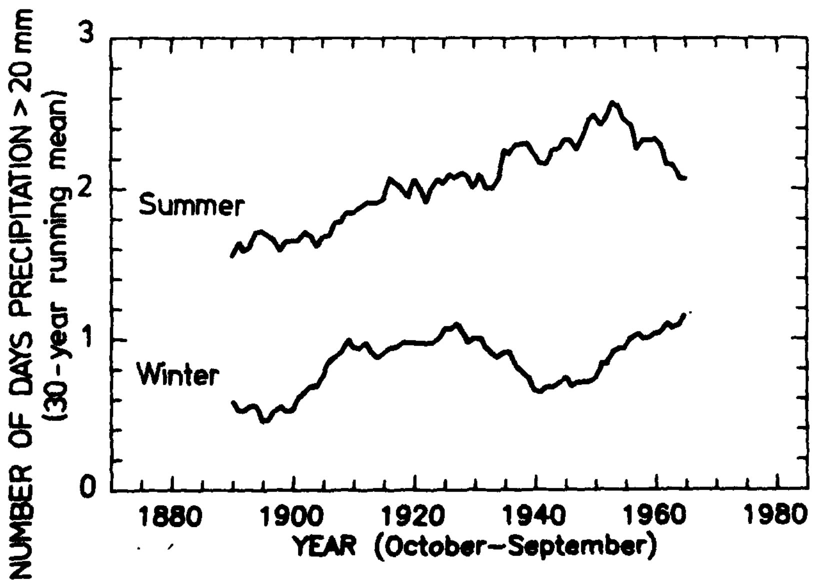


Fig. 3.3.3c. 30-year running means of the number of days each summer and each winter, at Fanø, when the precipitation exceeded 20 mm.

These showers occur mostly in the summer. Figure 3.3.3b shows the 30-year running mean of the occurrence of showers. The trend is toward increasing shower activity throughout most of this century. Figure 3.3.3c shows the summer and winter contributions to the climatological trend in yearly shower activity. The winter amount of shower activity seems to have peaked in the 1920's and has been rising again since about 1940. The climatological peak in the summer shower activity occurred in 1953.

3.3.4. Mean Monthly Precipitation

Figure 3.3.4 shows the averages and standard deviations over the whole record (1875-1980) of the monthly precipitation at Fanø. One can see by the sizes of the standard deviations that the variation in precipitation is quite large.

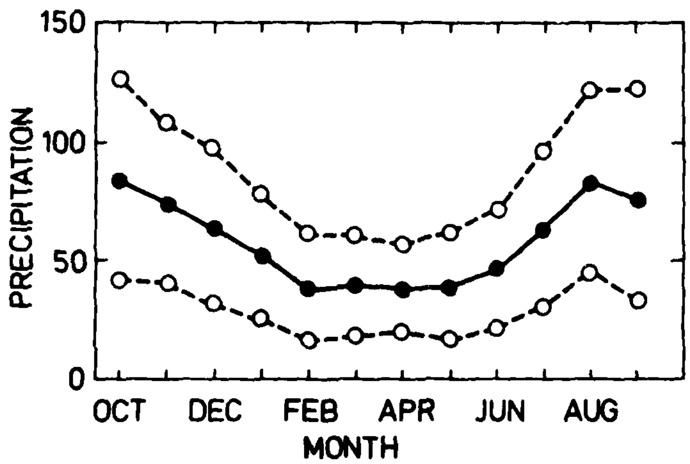


Fig. 3.3.4. Averages and standard deviations (1875-1980) of the monthly precipitation at Fanø.

3.3.5. Conclusion

It appears that the climatological increase in precipitation which occurred during the first half of the 20th century resulted mainly from an increase in shower activity. This conclusion follows from the observation that although there has been increased precipitation during this period, there have

also been longer dry periods and greater numbers of days in which there was more than the usual amount of precipitation.

3.4. Pressure

3.4.1. Mean Annual Pressure

Atmospheric pressure at Fanø was measured daily at the three observation times, 0800, 1400, and 2100. Figure 3.4.1a shows a plot of the annual average pressure, for each of the obser-

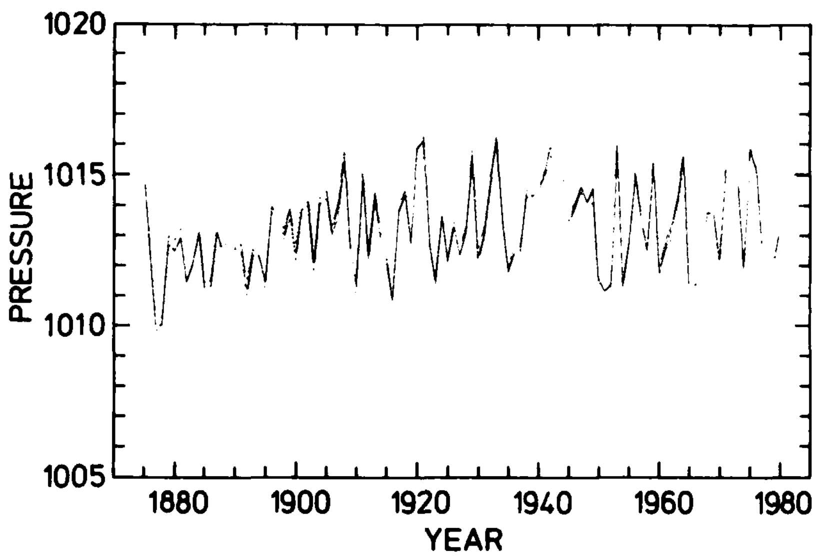


Fig. 3.4.1a. Annual average atmospheric pressure at Fanø for the observation times, 0800, 1400, and 2100, as a function of year.

vation times, as a function of year. The 30-year running means of the pressures measured at the three observation times are shown in Fig. 3.4.1b. The diurnal variation in pressure shows up clearly in the graph, and there is, climatologically, a trend toward increasing pressure from the last part of the 19th century up to about 1933, followed by a decline to the present day. One would expect that if this trend is real, a decrease in

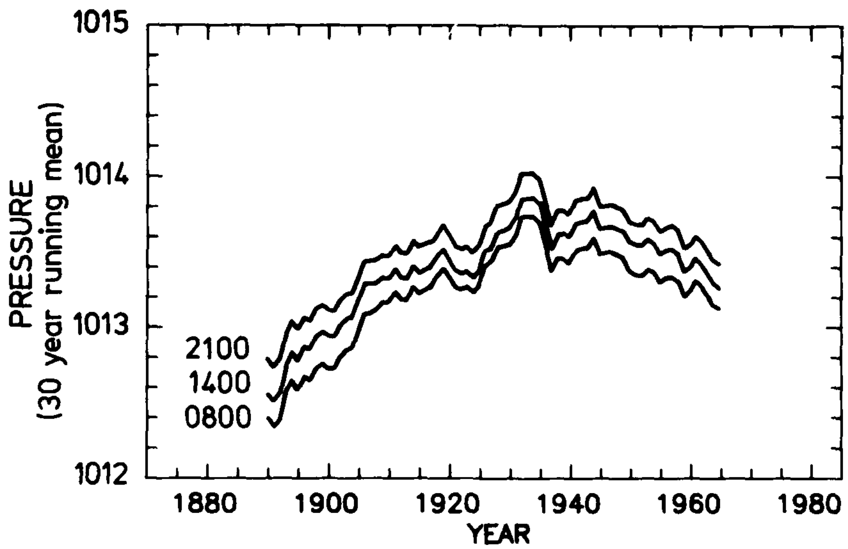


Fig. 3.4.1b. 30-year running mean of the atmospheric pressure at Fanø for the observation times, 0800, 1400, 2100.

cloudiness and in the frequency of passage of cyclones would also be discernible from the record.

3.4.2. Frequency of Cyclones

A cyclone was presumed to have passed the station at Fanø if the pressure dipped to below 990 mb, or below 980 mb, before rising again to more than 1000 mb. Figure 3.4.2a show the annual number of cyclones (pressure < 990 mb) observed at Fanø, as a function of year. The number ranges from a high of 13 in 1915 to a low of two in 1923. Figure 3.4.2b shows the number of cyclones with pressures less than 980 mb observed each year. There was a high of six in 1961 and a low of zero in 1930, 1934, 1943, 1947, and 1964. Figure 3.4.2c shows the 30-year running mean of the number of cyclones, with pressures less than 990 mb, passing the station each year. A climatological decrease of more than 20% in the number of cyclones occurred between the end of the 19th century and the 1930's. There appears to be a small trend toward an increase in the number of cyclones passing the station at Fanø since the 1930's.

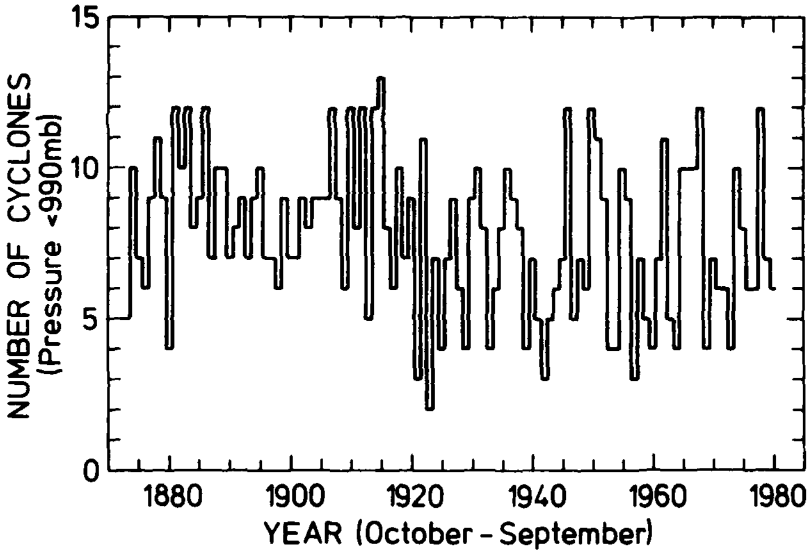


Fig. 3.4.2a. Annual number of cyclones (pressure < 990 mb) passing Fanø, as a function of year.

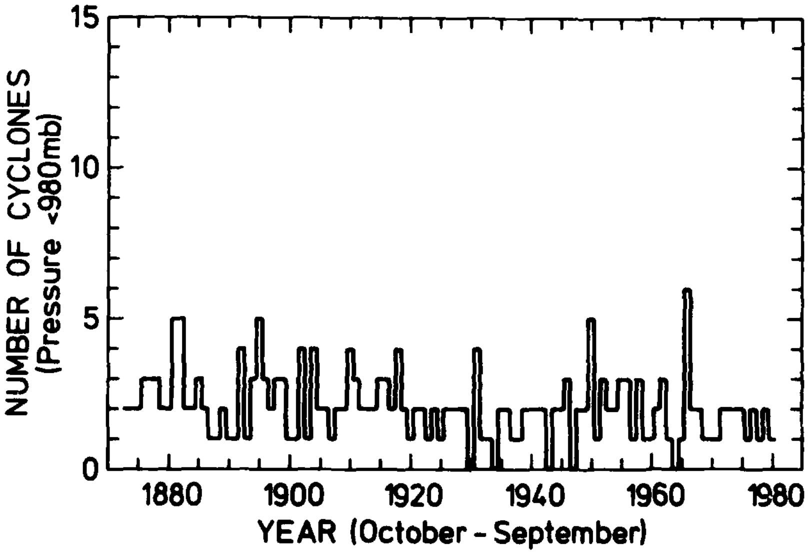


Fig. 3.4.2b. Annual number of cyclones (pressure < 980 mb) passing Fanø, as a function of year.

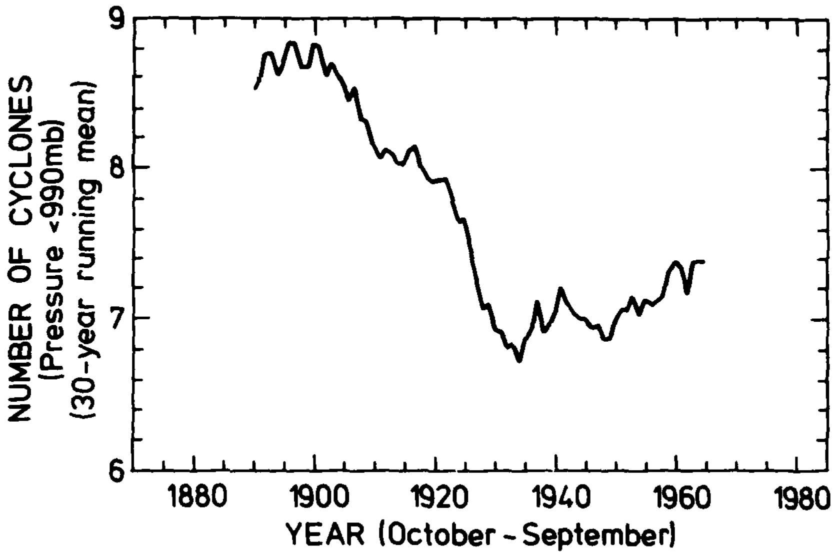


Fig. 3.4.2c. 30-year running mean of the annual number of cyclones (pressure < 990 mb) passing Fanø.

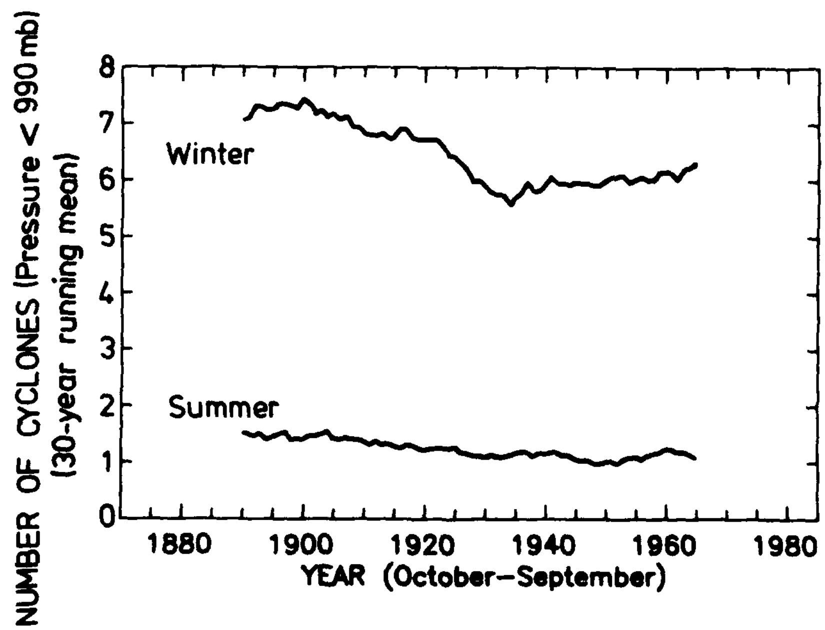


Fig. 3.4.2d. 30-year running means of the annual number of summer and winter cyclones (pressure < 990 mb) passing Fanø.

Most cyclone passages occur in the winter half of the year. Figure 3.4.2d shows the 30-year running means of the number of cyclone passages (pressure < 990 mb) during summer (April-September) and during winter (October-March). One can see that most of the trend in the annual number of cyclone passages is accounted for by the variation in the number of winter cyclones. Although the number of cyclone passages is determined from the pressure record and is thus not independent of it, the apparent climatological decrease in cyclone passage during the first third of the 20th century goes along with the climatological increase in mean pressure discernible from the atmospheric pressure record from Fanø.

A maximum in the zonal index, which corresponds to a minimum in the number of surface cyclone passages, has also been determined to have occurred in the 1930's (see Lamb, 1972, pp. 269-272). There apparently has been increased storminess in the 1950's relative to the 1930's, resulting from a southward movement of the mean storm track (Lamb, 1969, p. 219). These observations are consistent with the findings from the Fanø pressure record.

3.5. Cloudiness

3.5.1. Mean annual Cloud Cover

Mean cloudiness in octals for each of the observation times, 0800, 1400, and 2100, at Fanø are shown in Fig. 3.5.1a. For, most years it is, on the average, most cloudly at 0800 and least cloudy at 2100. Figure 3.5.1b shows the 30-year running mean of the cloudiness for the hours of 0800, 1400, 2100. There is a definite climatological maximum cloudiness occurring around 1912 and a minimum in the late 1930's to the early 1940's. There is a curious convergence of the curves for 1400 and 2100 hours. The cause is unknown but it is hard to attribute this to observer error. Possibly some local pollution source has developed since the late 1940's causing an increase in evening cloudiness. Figure 3.5.1c shows the 30-year running mean of the cloudiness for 1400 hours during the summer and during the winter months. The

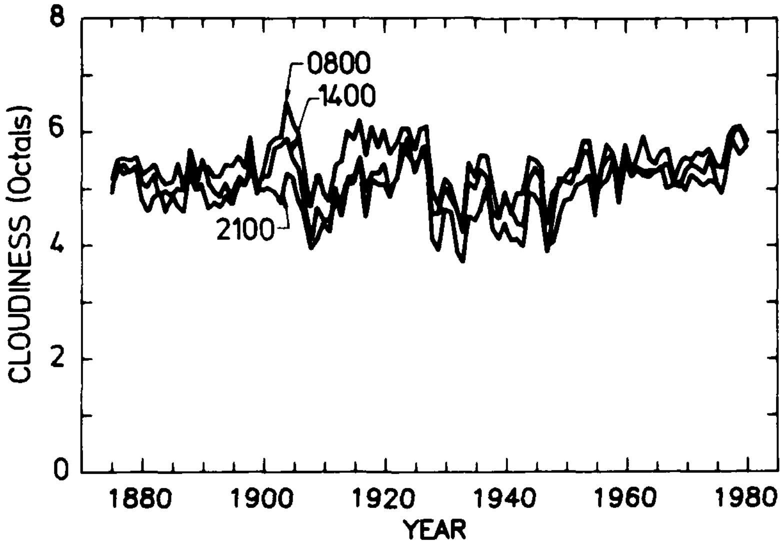


Fig. 3.5.1a. Annual mean cloudiness (octals) observed at Fanø at the times, 0800, 1400, and 2100, as a function of year.

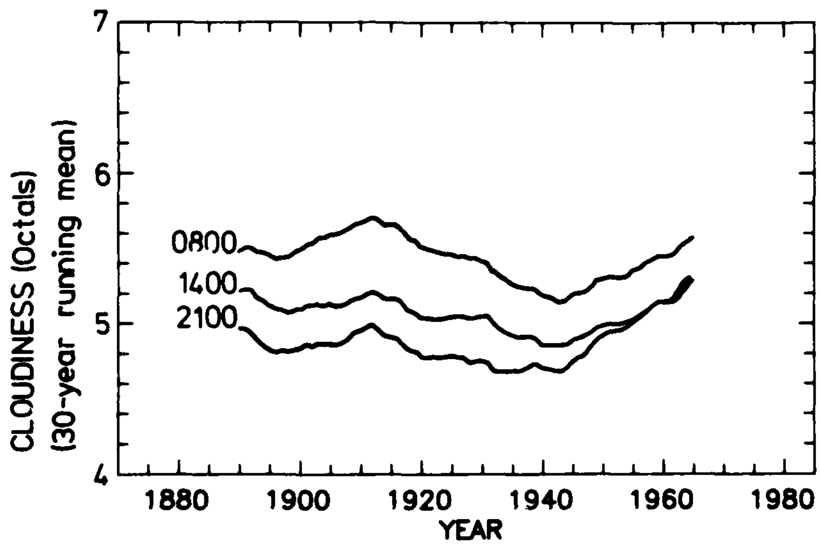


Fig. 3.5.1b. 30-year running means of the cloudiness observed at 0800, 1400, and 2100, at Fanø.

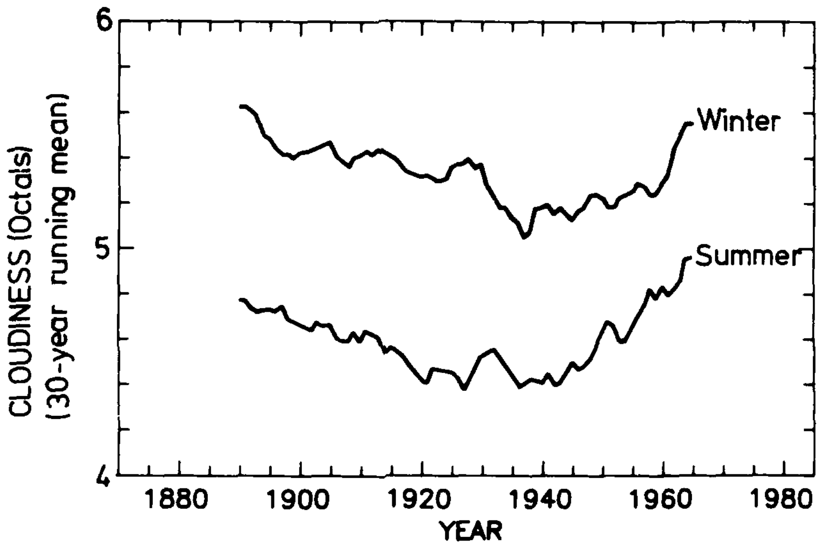


Fig. 3.5.1c. 30-year running means of the cloudiness observed at 1400 during summer and during winter at Fanø.

maximum in cloudiness around 1912, which was observed in the 30-year average annual cloudiness (Fig. 3.5.1b), is not apparent here. The climatological minimum in cloudiness in the period around the 1930's is easily seen, however.

The trends toward decreased cloudiness and increased pressure during the first third of the 1900's are consistent with each other in that high pressure regions tend to be less cloudy than low pressure regions. Since the two observations, pressure and cloudiness, are independent of each other, it is probable that the trends are real and not some artifact of the observation or data analysis process.

3.6. Visibility

Figure 3.6 shows the visibility (scale 0-9) observed at Fanø for the three observation times, 0800, 1400, and 2100. The record is too short for any meaningful climatological analysis to be undertaken.

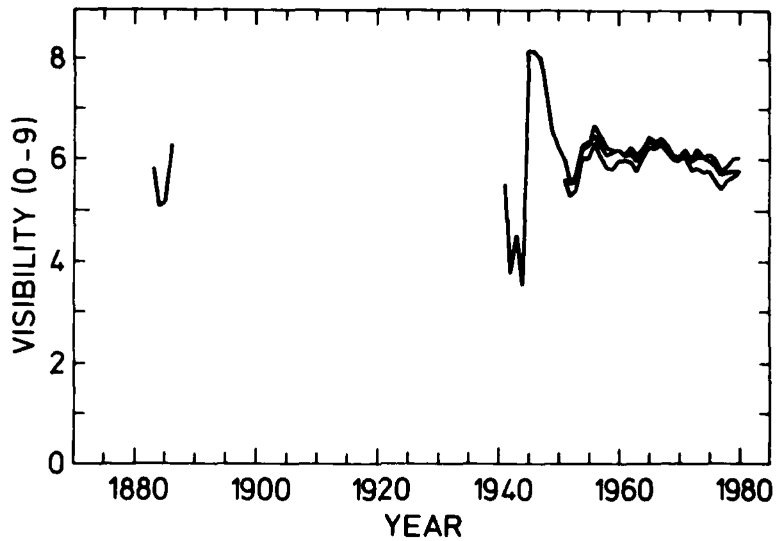


Fig. 3.6. Visibility (0-9) observed at 0800, 1400, and 2100, at Fanø, as a function of year.

3.7. Winds

3.7.1. Wind Speed

An analysis of the wind record from Fanø for climatic variations is difficult, and may be impossible, for several reasons, including: 1) the wind speed and direction are estimated subjectively by the observer rather than being objectively measured by instruments; 2) observers and sites of observation have changed over time; 3) the scale in which the winds are reported has changed from a seven-category land scale to the 13-category Beaufort or sea scale; and 4) the assignment of a numerical value to the observed wind is a subjective judgment and has no one-to-one correspondence with the wind speed (Alcock and Morgan, 1978).

There are advantages in using the record of a trained observer who has recorded his observations using the Beaufort scale. Anemometer records are fallible; anemometers are quite often poorly sited, so that their measurements are not representative

of the overall wind conditions in the area; they do not always operate properly; their maintenance may not be sufficient; and for low wind speeds they may not operate at all. A trained observer, on the other hand, can record overall wind conditions, can distinguish between calm and low wind speeds, and naturally tends to report an integrated observation of the prevailing conditions rather than making a nearly instantaneous observation of the present wind speed and direction at a particular location. The Beaufort system of wind classification can be a rather useful if imprecise measure of the state of the wind. For determining the presence of air stagnation conditions, it may be better than anemometer records; however, though it may be used for rough estimates, for quantifying available wind power a well-situated anemometer is necessary. Unfortunately there are few anemometers located at potential sites for the establishment of wind generators.

While most observers appeared to be consistent in their own method of reporting the wind conditions at Fanø, there are large differences in the frequency distributions of the observed winds determined from the reports of each observer. The frequency distribution of the wind force during the 1930's is quite different than, and inconsistent with, the distributions before or after that time.

Prior to 1911 a seven-category land scale was used to report the force of the wind; after 1911 a 13-category Beaufort or sea scale was used. The two-systems do not directly correspond to each other and, in order to have a foundation on which to match the two reporting systems, it was necessary to assume that the winds during the later part of the record were essentially the same as those during the early part of the record. Thus one must assume that there has been no significant change in the wind climate between the last part of the 19th century and the middle part of the present century in order to be able to match the old 0-6 category wind scale with the modern Beaufort scale. The land scale had been arbitrarily fit to the Beaufort scale simply by doubling the scale value of the old system. Thus, e. g., category or Force 2 in the old system would be assigned

Force 4 in the new system. This resulted in a large difference in the frequency distributions of the wind forces, between those reported before 1911 and those reported after 1911. Obviously the climate change implied by such a radical change in the winds is highly unlikely.

In Table 3.7.1 are shown both the land scale and sea scale and the variations in the sea scale or Beaufort system over the century (Hartby, 1981). The wind speed intervals associated with the Beaufort categories have changed over time, underlining the difficulty in assigning wind speeds to Beaufort numbers. The assumed correspondence between the two systems, as shown in the table, results from the best fit that could be obtained by matching the frequency distributions of the winds reported in the early part of the record to those reported in the later part. Figures 3.7.1c shows that a reasonable match between 1874-1900 and 1956-1970 has been obtained. After the best match was obtained between the early and later parts of the record, the reports of one observer, Tingberg, who used both systems, were compared with each other. He made reports both in the period before 1911 and after the Beaufort system was introduced, one can see the consistency in the reports by Tingberg both in the old and new systems if one assumes that the obtained transformation, made by matching the early and later part of the record, is correct. In the remaining part of this section it is assumed that the new and old wind scales match according to the transformation given in Table 3.7.1.

Because of a lack of a definite correspondence between wind speed and Beaufort force, the winds are discussed in terms of force and not of speed, even though the raw data had been transformed from force number to units of speed (m/s). In this study the units of speed recorded on the Meteorological Institute computer tape were retransformed back to force number in the old land-scale system. The Beaufort system was not used because one cannot easily convert seven force categories into 13 without coming up with an unreasonable force frequency distribution, and also, by studying the frequency distribution of the winds when reported in the Beaufort 13-category system, one can

Table 3.7.1. Comparison between the Danish land and sea scales consistent with wind data from Fanø.

LAND SCALE	1895	SEA SCALE	1895	1911	1930's	1976
0	Stille 0-2 m/s	0	Calm* < 2 kts$	Vindstille 0-1 m/s	Stille 0-1 k/h	Stille <1 kts
1	Svag 2-6 m/s	1	Light Air < 7 kts	Let Brise 2-3 m/s	Svag Luftning 2-6 k/h	Svag Luftning 1-3 kts
2	Frisk 6-10 m/s	2	Light Breeze < 11 kts	Svag Kuling 4-5 m/s	Svag Brise e. Vind 7-12 k/h	Svag Vind 4-6 kts
		3	Gentle Breeze < 16 kts	Moderat Kuling 6-7 m/s	Let Brise e. Vind 13-18 k/h	Let Vind 7-10 kts
3	Stiv 10-15 m/s	4	Moderate Breeze < 20 kts	Frisk Kuling 8-9 m/s	Jævn Brise e. Vind 19-26 k/h	Jævn Vind 11-16 kts
		5	Fresh Breeze < 25 kts	Stiv Kuling 10-11 m/s	Frisk Brise e. Vind 27-35 k/h	Frisk Vind 17-21 kts
		6	Strong Breeze < 29 kts	Meget Stiv Kuling 12-13 m/s	Kuling e. Blæst 36-44 k/h	Hård Vind 22-27 kts
4	Haard 15-20.5 m/s	7	Moderate Gale < 35 kts	Haard Kuling 14-15 m/s	Stiv Kuling e. Blæst 45-54 k/h	Stiv Kuling e. Blæst 28-33 kts
		8	Fresh Gale < 42 kts	Stormende Kuling 16-18 m/s	Haard Kuling e. Blæst 55-65 k/h	Hård Kuling e. Blæst 34-40 kts
5	Storm 20.5-30 m/s	9	Strong Gale < 49 kts	Storm 19-21 m/s	Storm 66-77 k/h	Stormende Kuling 41-47 kts
		10	Whole Gale < 57 kts	Haard Storm 22-25 m/s	Stærk Storm 78-90 k/h	Storm 48-55 kts
6	Orkan >30 m/s	11	Storm < 66 kts	Orkanagtig Storm 26-30 m/s	Orkanagtig Storm 91-104 k/h	Stærk Storm 56-63 kts
		12	Hurricane < 79 kts	Orkan >30 m/s	Orkan >104 k/h	Orkan >64 kts

*Original Beaufort designations

$Wind speed units in this table are the primary units that were published with each version of the wind scale.

see that an observer, at least at a sea coast station, cannot distinguish 13 separate wind categories and tends to favor certain categories over others, resulting in unreasonable wind force distributions. The same kind problem occurs when trying subjectively to report the wind direction with the great precision of 36 ten-degree sectors or even with the lesser

precision of eight 45-degree sectors; this will be discussed in the following section on wind direction.

The annual mean wind force (land scale) is shown in Fig. 3.7.1a as a function of year. It varies from about force 1.5 to 2.4 and reveals no particular trend. This tends to support the transformation between the Beaufort and the land scale used in this study.

Figure 3.7.1b shows the year-to-year variation of the wind force frequency distribution for each wind force category. There are radical departures from the mean during the period between about 1920 and 1945. However, there is fairly good agreement between the periods 1875 to 1900 and 1945 to 1980 even though the winds in the later period were originally reported in the Beaufort system rather than in the land scale system used here. It is obvious from the data that there are severe discrepancies in the the wind reports in the 1920-1945 period.

Figure 3.7.1c shows the wind force frequency distributions for various parts of the wind record, selected for averaging by observer and by superficial similarities in the year-to-year frequency distribution. It shows that, after transformation from the Beaufort system to the land scale according to the scheme presented in Table 3.7.1, the frequency distribution for the early (1874-1900) and later (1956-1970) parts of the record are in good agreement. It also shows that with this transformation, the pre- and post-1911 observations by Tingberg are reasonably consistent with one another.

Figures 3.7.1d-3.7.1g show the vector-averaged winds by year and the 30-year running means of the vector-averaged winds for the three reporting times (0800, 1400, 2100) in which they were observed. There appears to be some small tendency for a decrease in each component over time but it is not obvious that this is real or an artifact of the record.

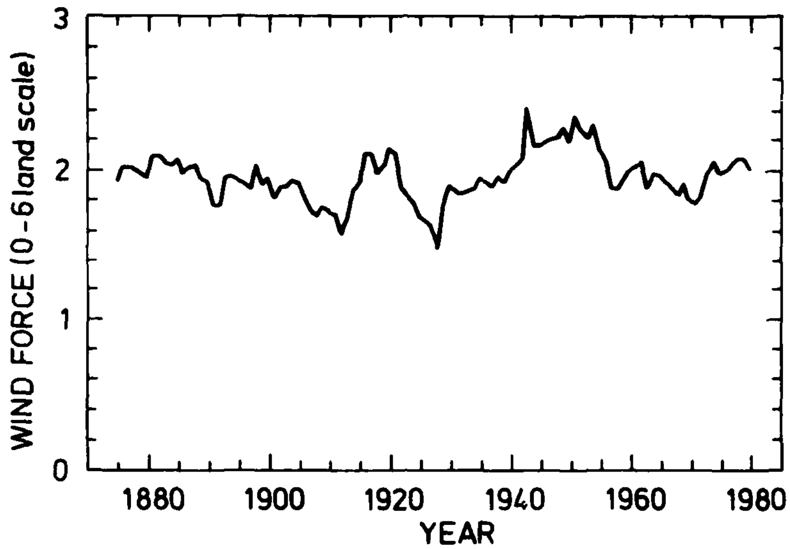


Fig. 3.7.1a. Mean annual wind force (0-6 land scale) at Fanø as a function of year. the wind force is averaged from daily reports at 0800, 1400, and 2100 hours.

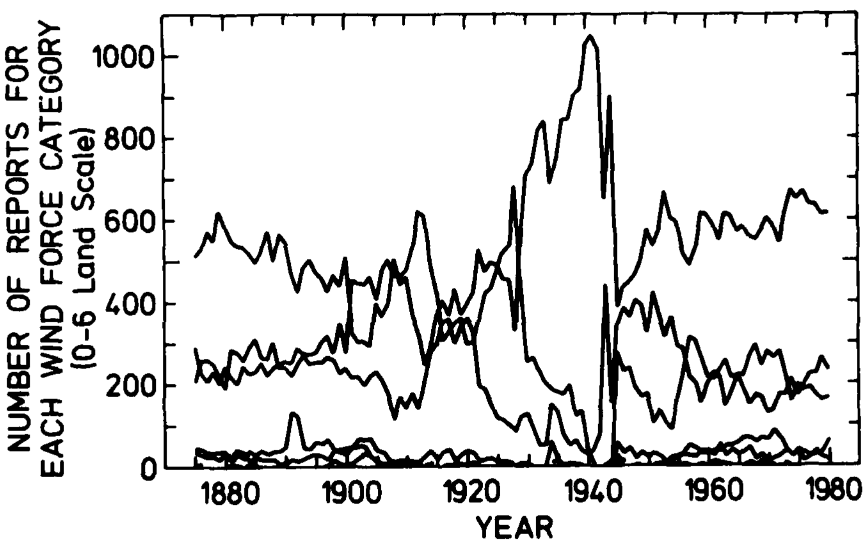


Fig. 3.7.1b. Number of reports of each wind category (0-6 land scale) per year from Fanø as a function of year. for the years after 1910 the winds were originally reported in the 13-category sea scale but have been reduced to the land scale according to the scheme shown in Table 3.7.1.

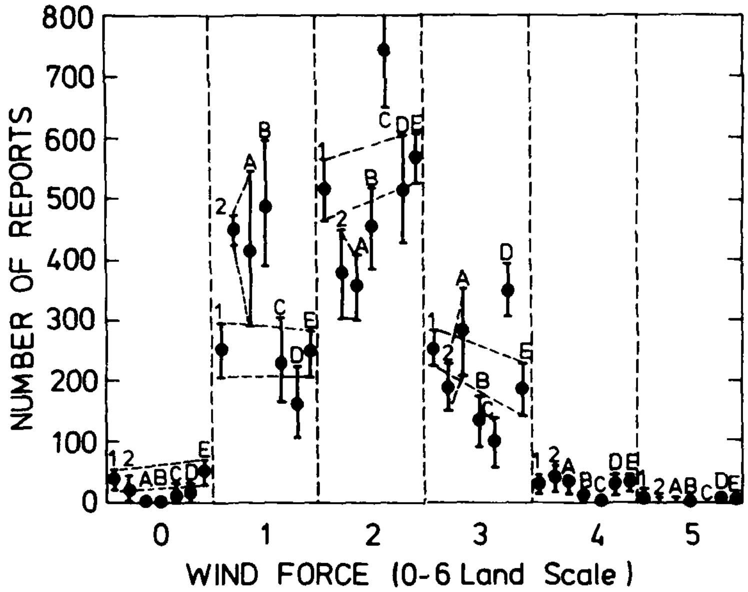


Fig. 3.7.1c. Average number of reports per year from Fanø of each wind speed category for selected periods. for the years after 1910 the original reported force numbers were reduced to the land scale according to the scheme shown in Table 3.7.1.

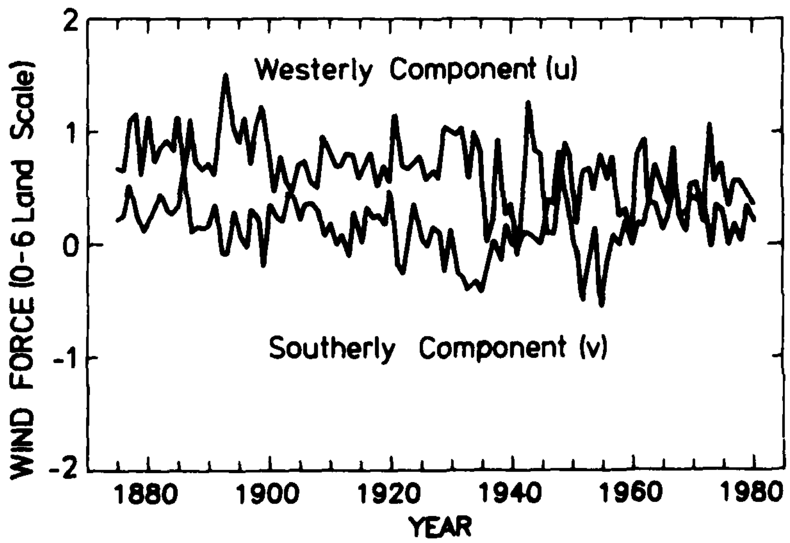


Fig. 3.7.1d. Annual mean wind vector components at Fanø (averaged from reports made of observations taken at 1400 hours) as functions of year.

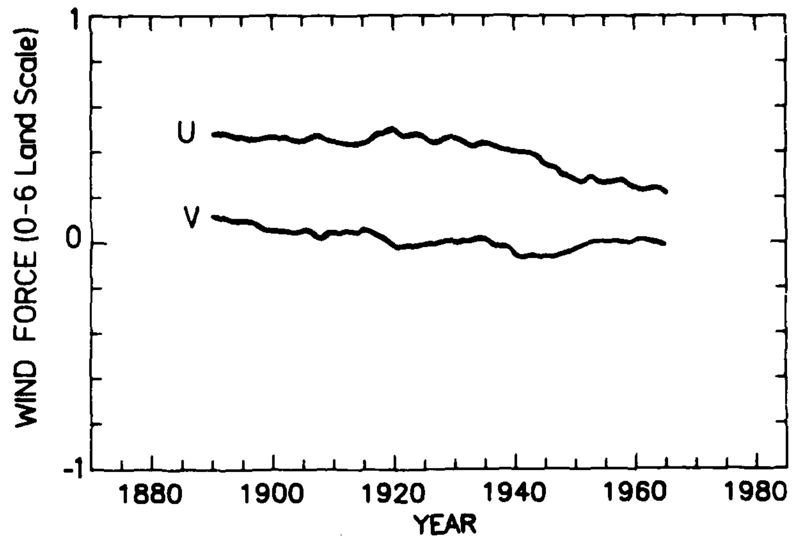


Fig. 3.7.1e. 30-year running mean of wind vector components at Fanø, from daily observations made at 0800 hours.

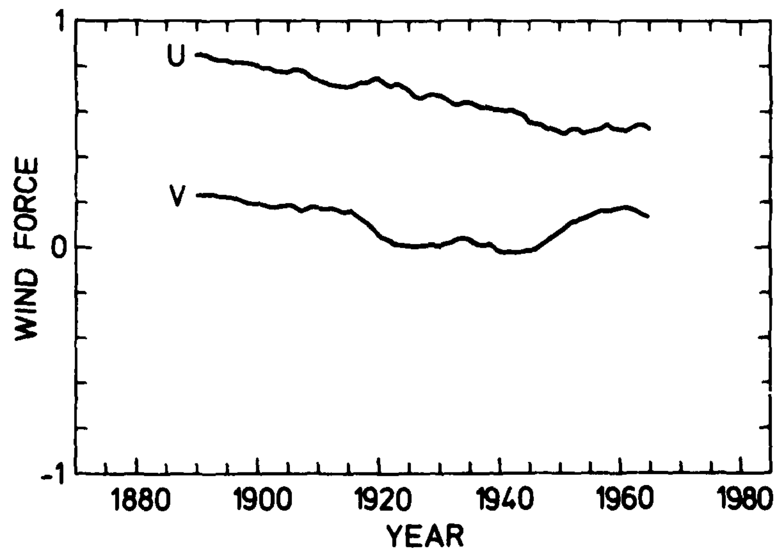


Fig. 3.7.1f. Same as Fig. 3.7.1e but from observations made at 1400 hours.

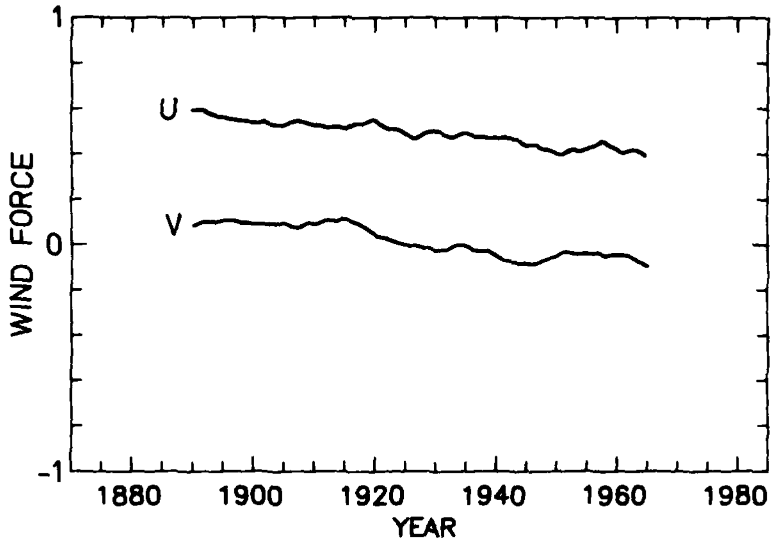


Fig. 3.7.1g. Same as Fig. 3.7.1e but from observations made at 2100 hours.

3.7.2. Wind Direction

Wind directions were originally reported in terms of the eight points of the compass, but were later ocnverted to 36 ten-degree sectors. However, if one studies the frequency distributions of the reported winds, it is obvious that there are observer favored wind directions, most likely due to the observer being unable to distinquish wind direction to such precision, and also due to the fact that for the early part of the record, when only eight directions were used, unreasonable frequency distributions would necessarily be obtained when transforming to 36 directions. In this study the wind directions were reconverted to the eight compass points of the original reports.

Figure 3.7.2a shows the frequency distributions of the wind directions for each point (45-degree sector) of the compass. The wild gyrations in the middle part of the record are obvious, as well as the much greater frequency of the westerly wind direction (most frequent) in the record from 1875 to about 1907.

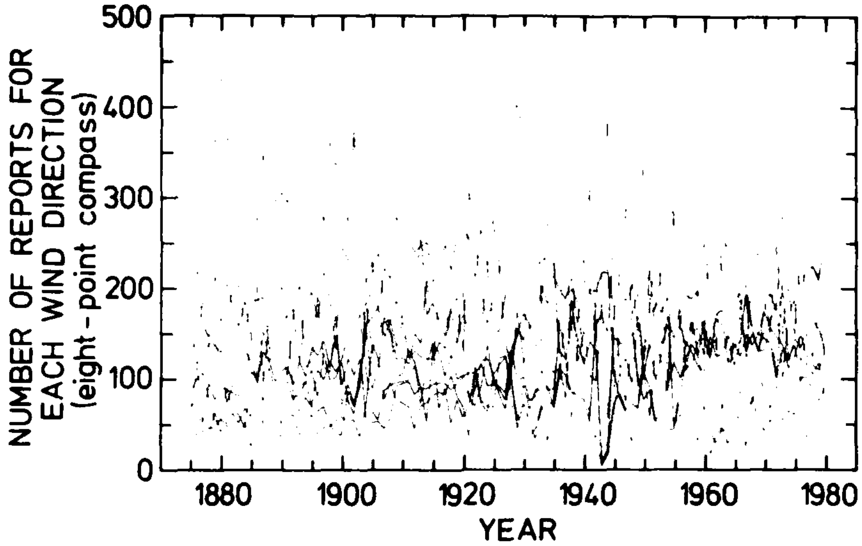


Fig. 3.7.2a. Number of reports per year from Fanø of each of the wind directions (eight-point compass) as functions of year.

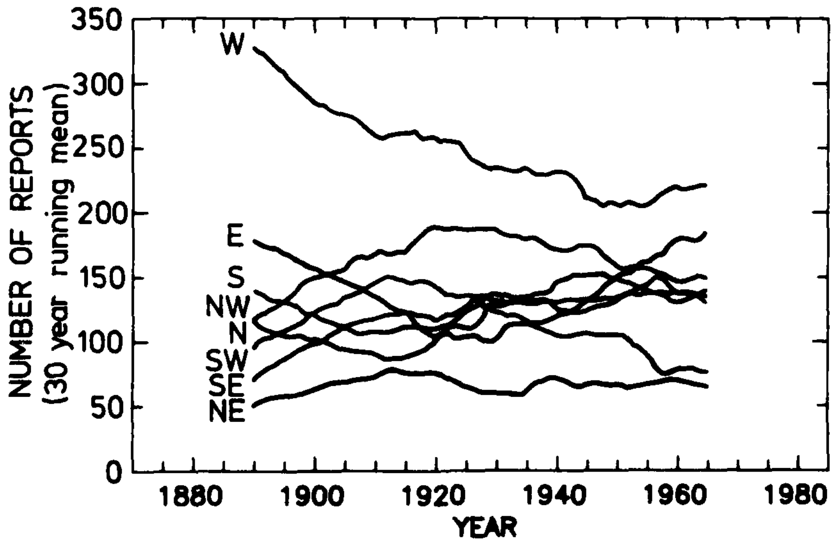


Fig. 3.7.2b. 30-year running mean number of reports per year from Fanø of each wind direction (eight-point compass).

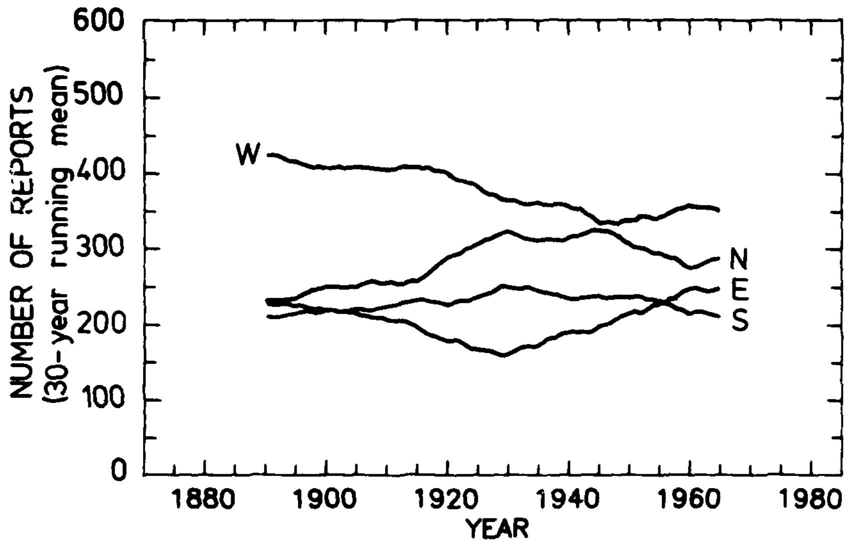


Fig. 3.7.2c. 30-year running mean number of reports per year from Fanø of each wind direction (four cardinal directions) as functions of year.

Figure 3.7.2b shows the 30-year running mean of the frequency distributions of the eight wind directions. The bias by the observer for the four cardinal directions is obvious in the early part of the record. In order to remove this bias, the wind directions were reduced again to the four cardinal directions and the frequency distributions of these directions are shown in Fig. 3.7.2c.

It is difficult to draw conclusions from the trends in wind direction shown in this Fig. 3.7.2c. There appears to be a general decline in the frequency of westerly winds, however, the distinct minimum in the frequency of easterlies is probably due to the, apparently, very poor quality of the wind reports in the years just prior to and during World War II.

3.7.3. Conclusions

One must not make too much of the winds reported at Fanø. If there are any trends in wind speed, they cannot be determined

from this record. There may be trends in wind direction, particularly the apparent decline in the frequency of westerlies, but these require supporting evidence before they can be taken seriously.

The modern day tendency to make all observations objective and precise may not always yield hoped-for results. From the Fanø data it seems apparent that an observer is unable to divide winds into 13 categories and 10 directions without the aid of instruments and, when observations are reported to such precision, the resulting frequency distributions tend to be unreasonable. It seems that, unaided by instruments, a land-based observer should not be expected to distinguish between more that 7 categories of wind force and 8 compass directions.

3.8. Statistics of Weather Variables

3.8.1. Means and Standard Deviations

Table 3.8.1 gives the means and standard deviations of over the period from 1875 to 1980 of the annual averages of most of the weather variables measured at Fanø and of some of the quantities derived from the data.

3.8.2. Trend Analysis

Linear and parabolic regression statistics were computed for most of the annual averages of the weather variables on year. The interannual variations of the yearly averages of the variables are so large, however, that any trends which exist are hidden by the interannual variations. As can be seen in the preceeding sectional of this report, many apparently real trends were found in the variables, after long-term running means were computed in order to dampen the high-frequency interannual variations.

A regression computation was made of the summer temperature on the preceeding winter temperature in order to find out if there is any relation between the summer temperature and the preceeding winter temperature. No correlation was found.

Table 3.8.1. Statistics of annual averages of weather variables at Fanø for the period 1875 through 1980.

Variable	Units	Mean	Standard Deviation
Temperature	C		
annual		8.1	0.6
summer		14.3	0.9
winter		2.0	1.3
daily maximum		11.0	1.0
daily minimum		5.2	0.8
daily range		5.8	0.7
at 1400		10.0	0.9
Degreedays (base 17C)	deg days		
annual	/year	3291	271
heating season (Oct-Apr)		2803	233
Dew point (at 1400)	C	6.5	1.0
Precipitation	mm/yr	705	119
>20 mm/day	days/yr		
summer		1.9	1.4
winter		1.4	1.0
Pressure (at 1400)	mb	1013.2	1.5
Cyclones (p < 990mb)	number/yr	8.5	7.0
Cloudiness (at 1400)	octals	5.1	0.4

ACKNOWLEDGEMENTS

This study was supported in part by the CEC Climate Program, Contract No. CLI-049-DK(G). The research was contributed to by N. Brown, S. Larsen, L. Kristensen, K. Frydendahl, and H.R. Olesen.

REFERENCES

ALCOCK, R.K. and MORGAN, D.G. (1980) Investigations of wind and sea state with respect to the Beaufort scale. WEATHER, 33, 271-277.

BROWN, N., OLESEN, H.R., PRAHM, L., and REITER, A. (1982). Kvalitetskontrol af Fanø Data. (Miljøstyrelsens Luftforureningslaboratorium, Forsøgsanlæg Risø) Internal report.

HARTBY, S. (1981) Gamle og nye vindstyrkebetegnelser. VEJRET, July, 3rd. 16-23.

LAMB, H.H. (1969) Climatic Fluctuations. WORLD SURVEY OF CLIMATOLOGY, Vol. 2. Edited by H. Flohn, (Elsevier, Amsterdam) 266 pp.

LAMB, H.H. (1972) CLIMATE: PRESENT, PAST, AND FUTURE, Vol. 1, (Methuen, London) 613 pp.

WOETMANN, N. (1978): Variation of climate, as indicated by extended temperature records from Denmark, the Faroes and Greenland (including a short review of sun-weather relationships). In: Proceedings of the Nordic Symposium on Climatic Changes and Related Problems. Edited by K. Frydendahl (Danish Meteorological Institute, Climatological Papers, No. 4, 212-222.

A. APPENDIX

A.1. Annual Means

Table 5.1 lists the annual averages of the various quantitative weather variables in the Fanø record. The winds are vector averages of the observations, recorded or converted to the 0-6 category to Danish "land" scale.

A.2. Wind Data Frequency Distributions

Table 5.2 lists the frequency distributions in number of reports per year of the wind force (0-6 category land scale) and the wind direction (eight-point compass). Wind force observations after 1911 were recorded using the 0-12 category Beaufort system but have been converted here to the land scale by matching the frequency distributions from the early and late parts of the record. The wind direction data on the magnetic tape from the Danish Meteorological Institute were recorded in 10-degree increments but have been converted to the eight-point compass here.

Table 5.1. Annual averages of quantitative weather variables measured at Fane between 1872 and 1980.

FANDE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	YEARLY MEANS TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	WIND (B/F) V	VISI-BILITY (0-9)
1872				0.0	0.0	0.0	0.0		0		123			
	0800	1006.4	3.7					2.3		6.5		-0.01	0.86	0.0
	1400	1006.2	4.7					2.9		6.3		-0.12	0.96	0.0
	2100	1006.9	4.0					2.7		6.2		-0.06	1.15	0.0
1873				0.0	0.0	0.0	0.0		0		743			
	0800	1012.2	8.4					6.1		5.7		0.80	0.58	0.0
	1400	1012.6	10.0					6.7		5.5		1.29	0.59	0.0
	2100	1012.7	7.7					5.5		5.4		0.93	0.49	0.0
1874				9.6	5.2	12.2	7.0		2726		726			
	0800	1012.6	8.3					5.7		4.9		0.87	0.39	0.0
	1400	1012.6	9.7					6.1		4.7		1.25	0.44	0.0
	2100	1012.8	7.5					5.4		4.7		1.30	0.23	0.0
1875				7.3	5.8	10.2	4.4		3611		493			
	0800	1014.7	7.3					4.7		5.2		0.25	0.19	0.0
	1400	1014.7	9.2					5.1		5.0		0.66	0.21	0.0
	2100	1015.2	6.5					4.3		4.9		0.44	0.04	0.0
1876				7.4	5.2	10.0	4.9		3542		581			
	0800	1012.2	7.5					4.9		5.5		0.24	0.18	0.0
	1400	1012.2	9.1					5.4		5.4		0.64	0.24	0.0
	2100	1012.5	6.6					4.8		5.5		0.35	0.13	0.0
1877				7.6	5.4	10.5	4.9		3468		809			
	0800	1009.7	7.7					5.2		5.5		0.58	0.35	0.0
	1400	1009.9	9.3					5.9		5.4		1.10	0.52	0.0
	2100	1010.2	6.8					5.0		5.3		0.78	0.35	0.0
1878				8.4	5.8	11.3	5.5		3200		731			
	0800	1010.0	8.4					6.0		5.5		0.77	0.03	0.0
	1400	1010.0	10.3					6.7		5.3		1.17	0.24	0.0
	2100	1010.2	7.6					5.7		5.3		0.82	-0.02	0.0
1879				6.2	5.4	8.9	3.5		3971		722			
	0800	1012.6	6.2					3.8		5.6		0.33	-0.00	0.0
	1400	1013.0	7.7					4.6		5.4		0.62	0.09	0.0
	2100	1013.1	5.5					3.7		5.4		0.46	-0.04	0.0
1880				8.4	5.9	11.4	5.5		3196		668			
	0800	1012.4	8.4					5.6		5.2		0.67	0.02	0.0
	1400	1012.4	10.2					6.3		5.1		1.13	0.22	0.0
	2100	1012.9	7.4					5.4		4.8		0.73	0.04	0.0
1881				6.4	5.6	9.2	3.6		3891		568			
	0800	1012.9	6.4					4.0		5.3		0.39	0.20	0.0
	1400	1012.7	8.1					4.9		5.0		0.72	0.29	0.0
	2100	1013.2	5.6					4.0		4.6		0.56	0.22	0.0

RANGE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	V	VISI-BILITY (0-9)
1882				8.4	5.2	11.0	5.9		3161		842			
	0800	1011.3	8.3					6.3		5.5		0.48	0.37	0.0
	1400	1011.4	10.2					7.1		5.3		0.87	0.45	0.0
	2100	1011.8	7.6					6.0		4.8		0.63	0.33	0.0
1883				7.9	5.4	10.6	5.2		3373		664			
	0800	1011.9	7.5					5.1		5.2		0.49	0.32	5.9
	1400	1012.0	9.6					5.8		4.9		0.92	0.30	0.0
	2100	1012.4	6.8					4.9		5.0		0.71	0.22	0.0
1884				8.5	5.8	11.4	5.6		3156		702			
	0800	1013.0	8.4					5.8		5.1		0.29	0.20	5.1
	1400	1013.1	10.3					6.4		5.0		0.84	0.25	0.0
	2100	1013.2	7.5					5.6		4.6		0.43	0.14	0.0
1885				7.3	5.4	10.0	4.6		3560		613			
	0800	1011.1	7.2					4.6		5.1		0.58	0.29	5.2
	1400	1011.2	9.0					5.2		4.9		1.12	0.33	0.0
	2100	1011.4	6.3					4.3		4.9		0.64	0.23	0.0
1886				7.3	5.4	10.0	4.6		3554		587			
	0800	1011.1	7.1					4.9		5.5		0.13	0.44	6.4
	1400	1011.3	9.9					5.5		5.0		0.55	0.61	0.0
	2100	1011.4	6.4					4.6		4.7		0.35	0.36	0.0
1887				7.1	5.7	10.0	4.3		3629		400			
	0800	1013.0	6.9					4.5		5.0		0.84	0.05	0.0
	1400	1013.1	8.8					5.3		5.0		1.12	0.11	0.0
	2100	1013.4	6.0					4.4		4.6		0.97	0.04	0.0
1888				6.6	5.0	9.1	4.1		3812		502			
	0800	1012.2	6.3					4.2		5.7		0.38	0.12	0.0
	1400	1012.4	8.2					5.1		5.5		0.72	0.15	0.0
	2100	1012.6	5.8					4.2		5.3		0.56	0.10	0.0
1889				8.0	5.5	10.8	5.3		3328		527			
	0800	1012.3	7.7					5.4		5.3		0.30	0.09	0.0
	1400	1012.5	9.8					6.2		5.1		0.65	0.14	0.0
	2100	1012.7	7.0					5.2		5.0		0.34	0.15	0.0
1890				7.7	4.9	10.2	5.3		3394		650			
	0800	1012.5	7.4					5.6		5.4		0.47	0.08	0.0
	1400	1012.5	9.2					6.7		5.5		0.71	0.16	0.0
	2100	1013.0	6.8					5.5		5.0		0.58	0.14	0.0
1891				7.7	5.3	10.3	5.0		3445		615			
	0800	1012.4	7.3					5.3		5.4		0.34	0.23	0.0
	1400	1012.7	9.3					6.1		5.1		0.59	0.36	0.0
	2100	1012.6	6.8					5.2		4.7		0.41	0.24	0.0

RANGE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	V	VISI-BILITY (0-9)
1892				7.5	5.5	10.2	4.7		3513		588			
	0800	1010.9	6.6					4.4		5.2		0.69	-0.13	0.0
	1400	1011.1	9.0					5.3		5.0		1.04	-0.08	0.0
	2100	1011.5	6.3					4.4		4.8		0.62	-0.20	0.0
1893				8.3	6.0	11.3	5.3		3261		755			
	0800	1012.3	7.2					4.8		5.2		0.99	-0.26	0.0
	1400	1012.3	9.8					5.4		4.9		1.51	-0.10	0.0
	2100	1012.7	7.2					4.9		4.7		1.04	-0.17	0.0
1894				9.1	5.8	12.0	6.2		2933		749			
	0800	1011.9	7.9					5.9		5.5		0.57	0.13	0.0
	1400	1012.2	10.6					6.6		5.1		1.05	0.29	0.0
	2100	1012.2	8.0					5.9		4.9		0.78	0.06	0.0
1895				7.8	5.9	10.7	4.8		3409		744			
	0800	1011.1	6.6					4.7		5.4		0.46	-0.05	0.0
	1400	1011.4	9.4					5.8		4.9		0.89	0.07	0.0
	2100	1011.5	6.7					4.9		4.7		0.42	-0.11	0.0
1896				8.8	5.6	11.6	6.0		3093		681			
	0800	1013.8	7.6					5.6		5.6		0.67	-0.19	0.0
	1400	1013.9	10.1					6.3		5.3		1.12	-0.03	0.0
	2100	1013.9	7.7					5.7		5.1		0.83	-0.33	0.0
1897				8.6	5.6	11.4	5.8		3200		636			
	0800	1013.1	7.4					5.6		5.4		0.42	0.10	0.0
	1400	1013.4	10.1					6.3		5.0		0.70	0.32	0.0
	2100	1013.6	7.6					5.6		5.1		0.41	0.10	0.0
1898				9.1	4.9	11.5	6.6		2956		550			
	0800	1012.8	8.0					6.0		6.0		0.73	-0.00	0.0
	1400	1013.0	10.4					6.8		5.6		1.05	0.22	0.0
	2100	1013.2	8.2					6.2		5.4		0.85	0.02	0.0
1899				8.3	5.6	11.6	6.0		3071		577			
	0800	1013.5	7.8					5.6		5.0		0.82	-0.25	0.0
	1400	1013.4	10.4					6.2		4.9		1.22	-0.21	0.0
	2100	1013.9	7.9					5.7		5.0		0.89	-0.27	0.0
1900				8.1	5.2	10.7	5.5		3300		648			
	0800	1012.1	7.5					5.4		5.2		0.26	0.20	0.0
	1400	1012.3	9.8					6.4		5.2		0.77	0.36	0.0
	2100	1012.7	7.4					5.5		5.0		0.52	0.06	0.0
1901				8.2	5.7	11.0	5.4		3298		666			
	0800	1013.8	7.4					5.3		5.8		-0.04	0.06	0.0
	1400	1013.9	10.0					6.3		5.3		0.45	0.24	0.0
	2100	1014.3	7.2					5.2		5.0		0.25	0.08	0.0

FANOL YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	V	VISI-BILITY (0-9)
1902				7.0	5.2	9.6	4.4		3672		672			
	0800	1013.9	6.3					4.0		5.9		0.44	0.09	0.0
	1400	1014.1	8.6					5.0		5.7		0.77	0.19	0.0
	2100	1014.3	6.1					3.9		4.9		0.59	0.01	0.0
1903				8.2	4.9	10.7	5.8		3227		804			
	0800	1011.7	7.6					5.3		5.9		0.36	0.34	0.0
	1400	1012.0	9.7					6.3		5.8		0.55	0.46	0.0
	2100	1012.2	7.3					5.1		4.7		0.51	0.32	0.0
1904				8.2	5.4	10.9	5.5		3254		560			
	0800	1014.0	7.5					5.5		6.6		0.16	0.15	0.0
	1400	1014.3	9.8					6.3		5.9		0.46	0.44	0.0
	2100	1014.5	7.2					5.3		5.3		0.35	0.30	0.0
1905				7.9	5.4	10.7	5.2		3353		698			
	0800	1014.2	7.5					5.3		6.2		0.64	0.09	0.0
	1400	1014.4	9.6					6.1		5.5		0.70	0.22	0.0
	2100	1014.5	7.2					5.2		5.2		0.60	0.11	0.0
1906				8.1	5.4	10.8	5.4		3292		777			
	0800	1012.9	7.6					5.8		6.0		0.32	-0.01	0.0
	1400	1013.1	9.9					6.6		5.4		0.73	0.37	0.0
	2100	1013.3	7.4					5.6		4.8		0.51	0.29	0.0
1907				7.3	5.2	10.0	4.7		3530		590			
	0800	1013.6	6.8					4.9		5.2		0.32	0.13	0.0
	1400	1014.0	9.0					6.0		4.7		0.55	0.38	0.0
	2100	1014.1	6.7					4.9		4.5		0.32	0.37	0.0
1908				7.7	5.5	10.5	5.0		3407		645			
	0800	1015.4	7.1					5.3		4.7		0.19	0.10	0.0
	1400	1015.8	9.5					6.2		4.1		0.49	0.29	0.0
	2100	1015.8	7.0					5.2		4.0		0.20	0.30	0.0
1909				7.0	5.0	9.6	4.5		3633		638			
	0800	1012.3	6.5					4.6		5.3		0.51	-0.05	0.0
	1400	1012.7	8.6					5.9		4.7		0.96	0.06	0.0
	2100	1012.7	6.3					4.7		4.1		0.51	0.13	0.0
1910				8.7	5.5	11.4	5.9		3093		523			
	0800	1011.0	8.1					6.1		4.9		0.39	0.09	0.0
	1400	1011.3	10.6					7.2		4.5		0.81	0.19	0.0
	2100	1011.4	8.0					6.2		4.4		0.42	0.13	0.0
1911				8.8	5.5	11.6	6.1		3087		700			
	0800	1014.8	8.4					6.3		4.8		0.39	-0.17	0.0
	1400	1015.1	10.8					7.6		4.5		0.70	-0.02	0.0
	2100	1015.1	7.9					6.1		4.2		0.42	0.01	0.0

FANUE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	V	VISI-BILITY (0-9)
1912				7.6	5.4	10.4	4.9		3475		740			
	0800	1012.1	7.2					5.3		5.4		0.42	0.02	0.0
	1400	1012.3	9.6					6.6		4.8		0.69	0.09	0.0
	2100	1012.5	7.1					5.3		5.1		0.49	0.13	0.0
1913				8.5	5.6	11.3	5.7		3122		528			
	0800	1016.1	7.9					6.1		5.5		0.61	-0.24	0.0
	1400	1016.3	10.6					7.4		4.8		0.80	-0.11	0.0
	2100	1016.5	7.7					6.0		4.5		0.58	-0.02	0.0
1914				8.9	5.2	11.5	6.3		3060		707			
	0800	1012.8	8.4					6.5		6.0		0.69	0.19	0.0
	1400	1012.9	10.8					7.5		5.2		0.79	0.29	0.0
	2100	1013.1	8.2					6.4		5.1		0.52	0.31	0.0
1915				7.0	5.2	9.5	4.4		3676		764			
	0800	1012.0	6.9					4.8		5.9		0.30	-0.07	0.0
	1400	1012.2	8.9					5.9		5.2		0.57	0.02	0.0
	2100	1012.4	6.3					4.5		5.1		0.38	-0.02	0.0
1916				7.8	4.8	10.2	5.4		3373		847			
	0800	1010.8	7.8					5.9		6.3		0.31	0.24	0.0
	1400	1010.8	9.4					6.8		5.6		0.70	0.33	0.0
	2100	1010.8	7.2					5.6		5.5		0.54	0.23	0.0
1917				7.5	5.5	10.3	4.8		3522		803			
	0800	1013.7	7.7					5.2		5.6		0.48	0.27	0.0
	1400	1013.8	9.4					6.2		5.0		0.61	0.22	0.0
	2100	1014.0	6.7					4.7		4.5		0.56	0.23	0.0
1918				8.2	5.4	10.9	5.5		3237		678			
	0800	1014.1	8.1					6.1		6.1		0.20	0.12	0.0
	1400	1014.3	10.0					7.0		5.3		0.51	0.26	0.0
	2100	1014.5	7.5					5.7		5.2		0.39	0.20	0.0
1919				6.8	5.2	9.4	4.2		3723		691			
	0800	1012.7	6.7					4.6		5.7		0.44	-0.03	0.0
	1400	1012.8	8.5					5.5		5.3		0.69	0.16	0.0
	2100	1012.7	6.2					4.4		5.1		0.46	0.05	0.0
1920				8.3	5.1	10.8	5.7		3216		842			
	0800	1015.9	8.1					6.1		6.1		0.35	0.42	0.0
	1400	1015.8	10.0					7.1		5.5		0.55	0.49	0.0
	2100	1016.0	7.6					5.8		5.1		0.45	0.42	0.0
1921				8.7	6.0	11.7	5.7		3072		735			
	0800	1016.1	8.7					6.3		5.6		0.95	-0.18	0.0
	1400	1016.1	10.7					7.3		4.9		1.16	-0.18	0.0
	2100	1016.3	7.9					5.8		4.8		0.96	-0.21	0.0

RANGE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (M/S) U	V	VISI-BILITY (0-9)
1922				6.8	5.5	9.6	4.1		3715		721			
	0800	1012.6	6.7					4.6		5.8		0.52	-0.37	0.0
	1400	1012.7	8.6					5.6		5.2		0.70	-0.28	0.0
	2100	1012.8	6.1					4.0		5.1		0.57	-0.29	0.0
1923				7.4	5.4	10.1	4.7		3556		860			
	0800	1011.5	7.4					5.3		6.1		0.47	0.03	0.0
	1400	1011.3	9.1					6.2		5.8		0.66	0.12	0.0
	2100	1011.6	6.8					4.7		5.6		0.63	0.01	0.0
1924				7.4	5.0	9.9	4.9		3534		778			
	0800	1013.7	7.5					5.4		6.1		0.42	0.36	0.0
	1400	1013.5	9.1					6.5		5.6		0.73	0.36	0.0
	2100	1013.7	7.1					5.2		5.9		0.57	0.33	0.0
1925				8.2	5.1	10.8	5.6		3277		885			
	0800	1012.1	4.6					6.6		5.7		0.52	0.01	0.0
	1400	1012.1	12.1					7.3		5.4		0.79	0.03	0.0
	2100	1012.2	7.6					5.3		5.3		0.66	0.05	0.0
1926				8.3	5.3	10.9	5.6		3217		761			
	0800	1013.1	8.3					6.7		6.1		0.39	-0.13	0.0
	1400	1013.3	10.1					7.8		5.6		0.55	-0.03	0.0
	2100	1013.5	7.5					6.1		5.6		0.64	-0.08	0.0
1927				7.9	4.8	10.2	5.4		3397		862			
	0800	1012.3	7.8					5.9		6.1		0.44	0.05	0.0
	1400	1012.3	9.3					6.7		5.7		0.66	0.16	0.0
	2100	1012.6	7.1					5.2		5.8		0.54	0.17	0.0
1928				7.9	5.5	10.8	4.9		3342		726			
	0800	1013.0	7.6					5.7		5.0		0.37	0.10	0.0
	1400	1013.1	9.7					6.9		4.5		0.58	0.09	0.0
	2100	1013.3	7.1					5.2		4.1		0.38	0.11	0.0
1929				7.0	7.3	10.6	3.4		3673		702			
	0800	1015.4	6.4					3.3		4.7		0.88	-0.09	0.0
	1400	1015.6	9.6					5.2		4.6		1.03	-0.25	0.0
	2100	1015.9	6.0					3.1		3.9		0.87	-0.24	0.0
1930				8.9	6.9	12.3	5.4		3014		721			
	0800	1012.1	8.3					6.0		5.2		0.82	0.16	0.0
	1400	1012.2	11.2					7.2		5.1		1.00	0.13	0.0
	2100	1012.5	8.1					6.2		4.7		0.61	0.13	0.0
1931				7.6	6.9	11.0	4.2		3467		833			
	0800	1012.9	7.1					5.3		5.1		0.79	-0.21	0.0
	1400	1013.0	10.0					6.5		4.9		0.96	-0.26	0.0
	2100	1013.3	6.9					5.0		4.6		0.81	-0.24	0.0

RANGE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	WIND (B/F) V	VISI-BILITY (0-9)
1932				8.7	7.7	12.5	4.9		3123		780			
	0800	1014.6	8.1					5.8		4.6		0.87	-0.25	0.0
	1400	1014.8	11.5					7.6		4.6		1.02	-0.21	0.0
	2100	1014.8	7.8					6.0		3.9		0.80	-0.19	0.0
1933				8.5	7.5	12.3	4.8		3156		547			
	0800	1016.1	8.1					5.5		4.3		0.33	-0.31	0.0
	1400	1016.0	11.2					6.7		4.2		0.60	-0.39	0.0
	2100	1016.3	7.5					5.6		3.7		0.46	-0.42	0.0
1934				9.7	6.8	13.1	6.3		2725		792			
	0800	1013.3	9.0					6.9		5.5		0.66	-0.26	0.0
	1400	1013.5	11.9					8.1		5.2		0.99	-0.32	0.0
	2100	1013.7	8.7					7.0		4.6		0.81	-0.28	0.0
1935				8.5	7.5	12.2	4.7		3162		792			
	0800	1011.7	8.0					5.2		5.2		0.55	-0.42	0.0
	1400	1011.8	10.9					6.9		5.0		0.81	-0.43	0.0
	2100	1011.9	7.7					5.4		4.5		0.71	-0.53	0.0
1936				8.3	6.8	11.7	4.9		3232		789			
	0800	1012.4	8.0					4.5		5.6		-0.23	-0.05	0.0
	1400	1012.4	10.5					6.4		5.4		-0.00	-0.15	0.0
	2100	1012.7	7.9					4.6		4.7		-0.11	-0.06	0.0
1937				8.6	5.9	11.5	3.6		3180		736			
	0800	1012.4	8.0					5.7		5.6		0.04	0.03	0.0
	1400	1012.5	10.4					6.9		5.2		0.23	0.04	0.0
	2100	1012.6	7.9					5.6		5.1		-0.17	0.20	0.0
1938				9.2	5.9	12.2	6.3		2917		890			
	0800	1014.3	8.8					6.2		5.0		0.77	-0.02	0.0
	1400	1014.5	11.1					7.0		4.6		0.92	-0.12	0.0
	2100	1014.6	8.4					6.2		4.3		0.43	-0.13	0.0
1939				8.8	6.7	12.1	5.5		3103		595			
	0800	1014.0	8.2					5.6		4.5		0.11	0.27	0.0
	1400	1014.2	10.9					7.1		4.5		0.25	0.19	0.0
	2100	1014.3	7.9					5.8		4.1		0.11	0.07	0.0
1940				6.7	6.6	10.0	3.5		3768		710			
	0800	1014.1	6.1					4.3		5.0		0.09	0.13	0.0
	1400	1014.4	8.6					7.0		4.9		0.35	0.00	0.0
	2100	1014.6	6.4					4.6		4.4		0.08	-0.01	0.0
1941				7.0	6.4	10.2	3.9		3765		717			
	0800	1014.9	6.3					4.0		4.6		-0.23	0.07	0.0
	1400	1015.1	8.8					4.5		4.6		-0.07	-0.02	5.6
	2100	1015.0	6.7					4.1		4.1		-0.31	-0.04	0.0

ANNUAL YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	YEARLY MEANS TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	WIND (B/F) V	VISIBILITY (0-9)
1942				6.9	6.5	10.2	3.7		2726		507			
	0800	1015.6	6.4					4.2		5.0		0.23	0.04	0.0
	1400	1015.9	8.6					4.2		4.4		0.35	0.11	3.8
	2100	1016.1	6.6					3.9		4.2		0.27	0.02	0.0
1943				8.9	6.4	12.1	5.7		2998		528			
	0800	1015.2	8.4					7.6		4.9		1.10	0.09	0.0
	1400	1015.4	10.8					10.1		4.4		1.27	0.09	4.6
	2100	1015.9	8.8					8.2		4.0		1.14	-0.16	0.0
1944				8.6	6.2	11.7	5.4		3194		633			
	0800	1014.2	8.2					7.6		5.6		0.67	0.08	0.0
	1400	1014.8	10.3					9.4		5.2		0.81	0.05	3.5
	2100	1015.0	8.3					7.2		5.0		0.84	-0.01	0.0
1945				9.7	6.7	13.0	6.3		2775		770			
	0800	1013.4	9.0					8.2		5.5		0.49	-0.17	0.0
	1400	1013.5	11.7					9.6		5.4		0.78	-0.00	8.2
	2100	1013.8	9.0					8.4		4.9		0.77	-0.15	0.0
1946				8.7	6.6	12.0	5.4		3100		859			
	0800	1013.9	7.8					7.8		5.4		0.09	0.26	0.0
	1400	1014.0	10.7					7.9		5.2		0.09	0.42	8.2
	2100	1014.1	7.9					7.4		4.7		0.22	0.22	0.0
1947				8.5	7.7	12.3	4.6		3379		513			
	0800	1014.5	7.5					5.9		4.4		-0.16	0.17	0.0
	1400	1014.6	11.1					7.4		4.0		0.07	0.35	8.0
	2100	1014.6	7.5					5.9		3.9		0.02	0.20	0.0
1948				9.8	7.2	13.3	5.2		2753		801			
	0800	1013.9	8.8					6.6		5.0		0.16	0.61	0.0
	1400	1014.1	12.1					7.4		4.1		0.37	0.84	7.3
	2100	1014.1	8.9					6.9		4.5		0.37	0.75	0.0
1949				10.3	6.5	13.5	7.0		2563		663			
	0800	1014.1	9.6					7.5		5.1		0.66	0.21	0.0
	1400	1014.5	12.4					8.1		4.5		0.91	0.43	6.6
	2100	1014.6	9.2					7.5		5.2		0.88	0.30	0.0
1950				8.9	5.5	11.7	6.1		3035		1012			
	0800	1011.3	8.4					6.5		5.2		0.49	-0.17	0.0
	1400	1011.5	10.7					6.9		4.8		0.78	0.03	6.3
	2100	1011.6	8.5					6.7		5.2		0.65	-0.02	0.0
1951				8.9	5.5	11.6	6.1		3011		906			
	0800	1010.8	5.2					6.6		5.4		0.01	-0.31	5.7
	1400	1011.1	10.6					6.8		4.8		0.16	-0.14	6.0
	2100	1011.2	8.2					6.4		5.1		0.12	-0.13	6.1

RANGE YEAR	DATA TIME	YEARLY MEANS: PRESSURE (MB)	TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	V	VISI-BILITY (0-9)
1952				7.9	5.8	10.8	5.0		3346		780			
	0800	1011.0	7.3					5.8		5.3		0.51	-0.56	5.3
	1400	1011.3	9.9					6.6		5.1		0.65	-0.50	5.6
	2100	1011.4	7.4					5.9		5.5		0.68	-0.48	5.6
1953				9.5	5.7	12.4	6.7		2828		717			
	0800	1015.7	9.0					7.3		5.7		0.48	-0.28	5.5
	1400	1016.0	11.5					7.6		5.1		0.70	-0.21	5.7
	2100	1016.1	8.6					7.1		5.9		0.59	-0.22	5.6
1954				8.2	5.6	11.0	5.4		3246		863			
	0800	1011.2	7.8					5.9		5.7		0.19	-0.08	6.1
	1400	1011.4	10.1					6.4		5.3		0.46	0.17	6.3
	2100	1011.6	6.9					5.5		5.9		0.49	0.02	6.2
1955				8.2	6.2	11.3	5.1		3367		596			
	0800	1012.7	7.6					5.5		4.9		0.44	-0.71	6.1
	1400	1012.7	10.3					6.4		4.5		0.76	-0.56	6.4
	2100	1012.9	7.2					5.7		5.0		0.66	-0.54	6.4
1956				7.6	5.7	10.4	4.7		3481		535			
	0800	1014.9	7.2					4.5		5.4		0.39	-0.26	6.4
	1400	1015.0	9.5					5.1		5.3		0.60	-0.15	6.6
	2100	1015.1	7.0					4.6		5.1		0.43	-0.34	6.7
1957				8.7	5.7	11.6	5.9		3065		708			
	0800	1013.4	8.2					5.9		5.8		0.40	0.03	6.1
	1400	1013.6	10.6					6.5		5.6		0.77	0.08	6.3
	2100	1013.8	8.4					6.1		5.2		0.61	-0.13	6.5
1958				8.0	5.8	10.8	5.1		3353		888			
	0800	1012.5	7.7					5.7		5.6		0.10	-0.09	5.9
	1400	1012.5	9.9					6.6		5.6		0.25	-0.00	6.1
	2100	1012.6	7.8					5.8		5.5		0.28	-0.09	6.3
1959				9.3	6.8	12.7	5.9		2935		572			
	0800	1015.4	8.8					6.2		5.2		-0.04	0.11	5.9
	1400	1015.4	11.7					6.8		4.8		0.34	0.22	6.2
	2100	1015.5	8.9					6.3		4.8		0.28	-0.09	6.2
1960				8.4	5.3	11.0	5.7		3182		739			
	0800	1011.7	7.8					5.7		5.8		-0.20	-0.09	6.0
	1400	1011.7	10.1					6.5		5.6		-0.02	-0.01	6.2
	2100	1012.0	8.0					5.8		5.6		-0.02	-0.16	6.2
1961				8.9	5.4	11.6	6.3		2970		823			
	0800	1012.5	8.5					6.3		5.3		0.60	-0.00	6.0
	1400	1012.6	10.6					7.1		5.3		0.80	0.20	6.1
	2100	1012.8	8.4					6.3		5.2		0.78	0.03	6.1

RANGE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	YEARLY MEANS TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	WIND (B/F) V	VISI-BILITY (0-9)
1962				7.5	5.3	10.1	4.9		3468		693			
	0800	1012.9	7.1					5.1		5.6		0.49	-0.05	6.0
	1400	1013.2	9.3					5.7		5.4		0.93	0.16	6.3
	2100	1013.4	7.1					5.1		5.4		0.91	-0.10	6.2
1963				7.2	5.7	10.1	4.3		3618		766			
	0800	1014.0	6.5					4.7		6.0		-0.02	0.19	5.8
	1400	1014.2	9.2					5.6		5.3		0.35	0.39	6.1
	2100	1014.3	6.6					4.7		5.3		0.15	0.12	6.0
1964				8.1	5.5	11.0	5.1		3279		657			
	0800	1015.4	7.4					5.4		5.6		0.27	0.09	6.1
	1400	1015.6	10.0					6.2		5.3		0.71	0.36	6.3
	2100	1015.8	7.4					5.5		5.2		0.42	0.00	6.2
1965				7.7	6.0	10.7	4.7		3392		855			
	0800	1010.8	6.9					5.1		5.4		0.28	-0.04	6.3
	1400	1011.2	9.9					5.8		5.3		0.54	0.13	6.5
	2100	1011.4	7.1					5.2		5.3		0.35	-0.08	6.4
1966				7.9	5.7	10.8	5.1		3360		825			
	0800	1010.9	7.0					5.3		5.7		0.09	0.02	6.3
	1400	1011.2	9.9					6.2		5.4		0.36	0.26	6.4
	2100	1011.3	7.3					5.5		5.4		0.19	-0.02	6.3
1967				9.2	5.8	12.1	6.3		2882		854			
	0800	1012.0	9.0					6.8		5.7		0.55	0.41	6.4
	1400	1012.3	11.1					7.2		5.5		0.87	0.57	6.5
	2100	1012.7	8.6					6.5		5.0		0.66	0.15	6.4
1968				8.6	6.3	11.3	5.4		3169		837			
	0800	1013.8	8.5					5.8		5.2		-0.05	0.09	6.2
	1400	1013.8	10.7					6.4		5.1		0.24	0.26	6.3
	2100	1014.0	7.9					5.7		5.1		0.15	-0.15	6.2
1969				8.1	6.4	11.3	4.9		3404		660			
	0800	1013.7	8.1					5.4		5.5		-0.09	0.03	6.1
	1400	1013.7	10.2					5.8		5.1		0.10	0.30	6.1
	2100	1013.8	7.1					5.0		5.2		0.02	-0.03	6.1
1970				7.8	6.2	10.9	4.7		3430		839			
	0800	1012.0	7.5					5.1		5.6		0.20	0.21	6.0
	1400	1012.2	10.0					5.9		5.4		0.54	0.42	6.1
	2100	1012.4	7.0					5.1		5.0		0.34	0.11	6.1
1971				9.1	6.3	12.3	6.0		2948		541			
	0800	1015.2	4.7					6.0		5.5		0.31	0.09	6.1
	1400	1015.2	11.2					6.3		5.5		0.56	0.40	6.3
	2100	1015.4	8.0					5.8		5.3		0.48	-0.11	6.1

FAMUE YEAR	DATA TIME	YEARLY MEANS PRESSURE (MB)	YEARLY MEANS TEMPERATURE (C)	MEAN TEMP (C)	TEMP RANGE (C)	MAX TEMP (C)	MIN TEMP (C)	DEW POINT (C)	DEGREE DAYS (BASE 17C)	CLOUDS (OCTALS)	PRECIP (MM)	WIND (B/F) U	WIND (B/F) V	VISI-BILITY (0-9)
1972				8.4	6.6	11.7	5.1		3221		520			
	0800	1015.1	7.9					5.6		5.7		-0.23	0.27	5.8
	1400	1015.3	10.7					6.0		5.4		0.19	0.43	6.0
	2100	1015.5	7.5					5.4		5.2		0.05	0.13	6.0
1973				8.7	6.0	11.7	5.7		3108		680			
	0800	1014.6	8.4					6.2		5.6		0.55	-0.12	5.9
	1400	1014.8	10.7					6.6		5.3		1.09	-0.02	6.3
	2100	1014.9	8.1					5.9		5.1		0.89	-0.37	6.1
1974				9.1	5.6	11.9	6.3		2915		871			
	0800	1011.9	8.6					6.5		5.7		0.24	0.17	5.8
	1400	1011.9	11.0					7.2		5.6		0.60	0.36	6.1
	2100	1012.0	8.6					6.4		5.2		0.39	0.05	6.1
1975				9.4	5.7	12.3	6.6		2895		579			
	0800	1015.8	9.1					6.5		5.4		0.37	0.23	5.8
	1400	1015.9	11.4					6.8		5.2		0.73	0.29	6.2
	2100	1015.9	8.9					6.5		5.1		0.55	-0.02	6.0
1976				8.1	6.2	11.2	5.0		3314		571			
	0800	1015.2	3.0					5.5		5.4		-0.03	0.00	5.6
	1400	1015.3	10.3					5.9		5.0		0.32	-0.01	6.1
	2100	1015.5	7.6					5.4		4.9		0.07	-0.16	5.9
1977				8.3	5.3	11.0	5.7		3190		723			
	0800	1012.4	3.2					6.1		5.9		0.20	0.10	5.4
	1400	1012.6	10.2					6.4		5.6		0.57	0.20	5.8
	2100	1012.8	8.1					6.0		5.7		0.42	0.04	5.8
1978				8.1	5.0	10.6	5.6		3289		682			
	0800	1012.5	8.0					5.9		6.1		0.16	0.02	5.6
	1400	1012.6	9.8					6.3		5.9		0.57	0.04	5.9
	2100	1012.8	7.7					5.8		6.1		0.25	-0.19	5.8
1979				7.1	5.1	9.6	4.5		3653		857			
	0800	1012.0	6.8					4.9		6.1		0.23	0.22	5.7
	1400	1012.2	8.7					5.4		5.6		0.46	0.35	6.1
	2100	1012.5	6.6					4.3		6.1		0.31	0.01	5.8
1980				7.9	5.7	10.8	5.1		3350		935			
	0800	1013.1	6.5					5.5		5.8		-0.07	0.12	5.8
	1400	1013.3	9.9					6.0		5.8		0.35	0.19	6.1
	2100	1013.5	7.5					5.6		5.9		0.22	-0.07	5.8

Table 5.2. Annual frequency distributions of wind force and direction at Fanø, 1872-1980.

YEAR	BEAUFORT FORCE FREQUENCY 0	1	2	3	4	5	6	MEAN	WIND DIRECTION FREQUENCY N	NE	E	SE	S	SW	W	NW	DATA
1872	6	66	231	465	150	108	0	2.9	126	54	209	42	377	73	165	30	[illegible]
1873	32	156	266	487	140	14	0	2.5	88	37	140	72	204	119	359	76	1095
1874	32	317	452	221	61	12	0	2.0	141	38	90	65	176	135	339	91	1095
1875	44	293	512	207	35	4	0	1.9	158	28	214	71	136	87	336	65	1095
1876	42	228	530	259	28	9	0	2.0	117	41	219	76	140	101	297	115	1073
1877	33	206	572	262	22	0	0	2.0	129	31	160	42	187	109	386	52	1095
1878	35	234	547	253	26	0	0	2.0	140	39	147	47	135	80	411	96	1095
1879	35	202	622	219	17	0	0	2.0	139	64	215	47	138	54	360	78	1095
1880	39	245	557	189	34	1	0	1.9	122	43	153	57	130	55	436	71	1098
1881	12	220	548	286	22	7	0	2.1	74	50	206	51	173	70	362	87	1095
1882	31	202	537	279	43	3	0	2.1	94	28	178	63	200	65	392	35	1095
1883	19	246	534	259	36	1	0	2.0	134	23	158	52	204	61	381	82	1095
1884	37	226	519	271	13	7	0	2.0	133	53	186	69	191	47	358	77	1098
1885	28	232	495	313	25	2	0	2.1	118	26	147	59	198	109	299	149	1095
1886	39	253	522	204	16	1	0	2.0	97	44	203	90	188	100	274	99	1095
1887	29	220	570	260	16	0	0	2.0	131	48	95	51	191	76	349	154	1095
1888	35	239	498	302	18	3	0	2.0	120	51	172	82	132	114	306	120	1098
1889	35	250	566	240	4	0	0	1.9	98	54	175	64	162	86	296	140	1095
1890	46	256	544	241	8	0	0	1.9	110	37	203	51	156	91	307	137	1095
1891	135	253	[illegible]	221	18	0	0	1.8	114	60	179	72	172	99	295	104	1095
1892	173	289	422	249	13	0	0	1.8	95	62	177	75	81	73	356	173	[illegible]
1893	43	275	435	272	20	0	0	2.0	120	39	119	66	83	91	372	205	1095
1894	40	271	504	249	28	3	0	2.0	104	49	166	81	98	99	364	114	1095
1895	60	277	473	254	31	0	0	1.9	136	62	177	71	111	71	325	122	1095
1896	55	302	457	253	27	1	0	1.9	127	40	169	65	82	112	328	[illegible]	1098
1897	66	317	424	268	16	4	0	1.9	143	47	219	70	125	103	273	114	1095
1898	34	275	464	260	41	16	0	2.0	114	48	189	53	100	120	363	104	1095
1899	40	349	439	227	35	5	0	1.9	149	54	133	40	102	109	337	171	1095
1900	43	274	507	237	30	2	0	1.9	94	57	246	37	124	119	342	72	[illegible]
1901	46	454	323	216	49	7	0	1.8	123	54	232	63	154	77	272	95	1095
1902	46	445	300	219	67	18	0	1.9	105	56	198	71	153	62	376	74	1095
1903	50	442	305	199	65	34	0	1.9	123	37	205	93	172	113	251	101	1095
1904	[illegible]	464	[illegible]	220	69	26	0	1.9	59	71	152	137	[illegible]	141	[illegible]	[illegible]	1098
1905	12	404	399	231	41	8	0	1.9	52	139	89	122	65	224	230	159	1095
1906	6	481	364	208	36	0	0	1.8	54	123	113	156	55	239	175	139	1095
1907	5	506	374	172	17	1	0	1.7	46	78	169	163	38	131	223	147	1095
1908	3	463	306	114	10	0	0	1.7	57	97	151	166	75	155	211	[illegible]	1098
1909	5	461	441	171	16	1	0	1.8	93	78	102	136	37	122	230	137	1095
1910	5	475	459	141	15	0	0	1.7	96	74	107	164	92	124	265	167	1095
1911	7	527	367	178	11	5	0	1.7	98	70	133	124	100	117	252	201	1095
1912	3	522	322	139	9	0	0	1.6	84	46	119	132	116	151	241	[illegible]	1098
1913	2	611	245	211	22	4	0	1.7	92	71	90	125	73	140	248	[illegible]	1095
1914	8	487	284	277	38	1	0	1.9	53	75	70	123	120	211	272	171	1095
1915	0	422	362	295	16	0	0	1.9	135	83	75	123	140	126	[illegible]	[illegible]	1095
1916	2	302	404	350	35	1	1	2.1	63	[illegible]	77	[illegible]	130	[illegible]	[illegible]	[illegible]	1098
1917	4	323	365	359	42	0	2	2.1	91	94	76	135	134	157	250	143	1095
1918	5	350	432	246	12	0	0	2.0	52	105	89	178	126	142	221	160	1095
1919	4	360	367	336	27	1	0	2.0	76	82	96	140	101	142	265	141	1095
1920	2	295	394	360	39	3	2	2.1	59	79	104	196	105	171	252	131	1098
1921	3	298	422	328	33	10	1	2.1	70	37	107	81	79	155	257	307	1095
1922	1	362	527	193	11	1	0	1.9	114	105	107	83	76	153	211	[illegible]	1095
1923	1	420	471	165	16	2	0	1.8	73	76	117	121	93	153	266	139	1095
1924	[illegible]	433	436	143	[illegible]	1	0	[illegible]	64	70	73	127	133	123	224	151	1098
1925	2	479	489	116	9	0	0	1.7	104	69	94	105	97	167	277	189	1095
1926	0	513	454	111	10	2	0	1.7	93	124	72	116	39	151	219	221	1095

1927	0	510	452	98	9	0	0	1.6	67	126	85	125	77	135	231	129	1095
1928	0	462	326	63	1	1	0	1.5	114	78	131	98	135	97	327	113	1096
1929	0	393	571	122	9	0	0	1.8	174	17	97	45	148	54	404	156	1095
1930	0	256	708	128	5	0	0	1.9	116	18	102	73	172	94	378	142	1095
1931	0	264	740	89	1	1	0	1.8	159	36	76	53	161	66	331	213	1095
1932	0	227	819	49	0	0	0	1.8	157	45	81	34	136	89	329	225	1073
1933	3	200	842	50	0	0	0	1.9	203	71	110	68	144	87	181	231	1095
1934	62	187	685	152	9	0	0	1.9	183	31	88	71	119	92	274	237	1095
1935	22	179	748	133	13	0	0	1.9	215	65	89	76	107	69	247	227	1095
1936	0	174	846	74	2	0	0	1.9	199	106	163	170	112	116	131	130	1092
1937	0	196	844	49	6	0	0	1.9	189	41	122	247	104	79	191	122	1095
1938	1	121	906	63	4	0	0	2.0	212	16	56	152	85	190	200	184	1095
1939	3	134	920	37	1	0	0	1.9	161	21	140	245	83	119	185	141	1095
1940	0	38	1029	28	0	0	0	2.0	209	23	117	229	78	155	120	166	1098
1941	0	4	1051	40	0	0	0	2.0	203	24	142	312	52	104	58	200	1095
1942	2	0	1015	77	1	0	0	2.1	145	39	131	148	178	98	159	197	1095
1943	0	2	650	440	3	0	0	2.4	218	4	6	12	279	165	172	219	1095
1944	6	17	903	153	13	3	0	2.1	221	29	17	18	385	56	152	217	1070
1945	20	276	385	347	59	5	2	2.2	107	73	167	63	87	146	270	182	1098
1946	11	229	437	385	32	1	0	2.2	79	84	218	107	156	139	200	111	1071
1947	0	238	449	363	45	1	0	2.2	63	66	292	75	151	139	186	123	1078
1948	18	186	466	403	18	3	0	2.2	31	73	168	152	206	171	200	75	1071
1949	0	166	501	391	35	2	0	2.3	68	68	92	101	158	196	241	171	1075
1950	0	176	576	323	20	0	0	2.2	107	135	107	77	106	102	339	121	1082
1951	4	103	533	423	32	0	0	2.3	58	222	138	88	91	146	173	179	1095
1952	3	134	575	359	23	1	0	2.2	142	147	98	45	52	134	179	242	1078
1953	6	104	666	311	7	1	0	2.2	115	139	131	46	74	173	224	193	1095
1954	12	86	603	364	22	8	0	2.3	86	160	169	44	94	191	254	97	1095
1955	18	168	593	270	24	1	1	2.1	286	48	144	44	117	44	274	118	1095
1956	34	227	517	257	24	5	0	2.1	157	60	173	78	102	93	266	161	1073
1957	51	314	488	215	25	2	0	1.9	136	56	109	124	112	141	224	193	1095
1958	43	305	525	200	21	1	0	1.9	163	59	148	138	117	129	152	189	1095
1959	31	258	614	152	36	4	0	1.9	127	30	202	125	143	114	186	198	1095
1960	30	217	611	199	36	1	0	2.0	165	72	251	81	145	109	126	148	1098
1961	36	210	588	227	25	9	0	2.0	127	17	197	43	122	148	302	139	1095
1962	36	231	548	217	52	8	3	2.0	167	37	132	29	171	125	291	143	1095
1963	50	258	615	143	23	6	0	1.9	161	47	257	44	177	128	215	66	1095
1964	48	212	610	182	40	3	0	2.0	118	28	245	44	132	149	276	135	1098
1965	55	221	570	221	26	2	0	2.0	147	59	185	74	136	115	239	140	1095
1966	70	219	584	186	34	2	0	1.9	170	57	196	87	143	141	176	125	1095
1967	68	265	559	149	46	7	1	1.9	132	25	122	72	135	193	206	150	1095
1968	57	295	550	174	18	1	0	1.8	150	80	223	74	153	120	159	138	1093
1969	69	261	575	167	30	13	0	1.9	131	53	241	111	132	128	149	150	1095
1970	64	278	606	130	11	6	0	1.8	133	43	187	85	154	174	175	145	1095
1971	87	263	585	138	17	4	0	1.8	157	55	159	67	162	159	195	139	1093
1972	69	280	545	177	25	0	0	1.8	147	44	247	93	134	101	177	101	1078
1973	40	217	620	174	37	7	0	2.0	138	34	148	54	101	133	282	207	1002
1974	22	158	676	214	24	1	0	2.1	112	46	202	65	172	124	254	120	1095
1975	40	198	651	172	32	2	0	2.0	126	53	149	61	198	133	235	149	1095
1976	30	133	670	176	12	3	0	2.0	149	54	242	102	117	97	198	135	1092
1977	21	191	637	222	21	3	0	2.0	125	35	185	102	151	113	220	159	1095
1978	26	170	637	224	37	1	0	2.1	115	46	226	86	124	105	225	165	1095
1979	35	159	614	265	21	1	0	2.1	110	39	209	76	175	118	213	155	1095
1980	61	166	617	234	15	2	0	2.0	132	30	256	91	123	77	254	133	1098

END

DATE

FILMED

2 84

DTIC